CONCEPTUAL CHANGE TEXT ORIENTED INSTRUCTION

TO FACILITATE CONCEPTUAL CHANGE IN ATOMS AND MOLECULES

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

BARIŞ GÜNAY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

JANUARY 2005

Approval of the Graduate School of Natural and Applied Sciences

_____

Prof. Dr. Canan ÖZGEN
Directory

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

_____

Prof. Dr. Ömer GEBAN
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

_____

Prof. Dr. Ömer GEBAN
Supervisor

Examining Committee Members

Prof. Dr. Hamide ERTEPINAR	(METU,ELE)	_____
Prof. Dr. Ömer GEBAN	(METU,SSME)	_____
Assist. Prof. Dr. Esen UZUNTİRYAKİ	(METU,SSME)	_____
Assist. Prof. Dr. Yezdan BOZ	(METU,SSME)	_____
Assist. Prof. Dr. Semra SUNGUR	(METU,ELE)	_____

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Barış GÜNAY

Signature :

ABSTRACT

CONCEPTUAL CHANGE TEXT ORIENTED INSRUCTION
TO FACILITATE CONCEPTUAL CHANGE IN ATOMS AND MOLECULES

GÜNAY, Barış
M.S., Department Secondary Science and Mathematics Education
Supervisor: Prof. Dr. Ömer GEBAN

January 2005, 100 pages

The main aim of this study to investigate the effectiveness of conceptual change texts oriented instruction accompanied with analogies over traditionally designed chemistry instruction on overcoming 10th grade students' misconceptions, their understanding atoms and molecules concepts and attitude towards chemistry as a school subject .

45 tenth grades students from two classes of a chemistry course taught by the same teacher in Elmadağ High School prticipated in the study that was carried out in 2004 –2005 Fall semester .

Two student groups participated in the study . One of them , called as Experimental

group , was instructed with conceptual change text oriented instruction accompanied with analogies and the other one , called as Control group , was instructed with traditionally designed chemistry instruction over a period of two weeks .

To investigate the effect of the treatment , Atoms and Molecules Concept Test and Attitude Scale Toward Chemistry as a school subject were administrated to all students in both groups at the begining and end of the the treatment . To evaluate students' science process skills , Science Process Skills Test was administrated before treatment .

ANCOVA and ANOVA were used to test the hypothesis of the study . The result of the study showed that students instructed with conceptual change text oriented instruction accompanied with analogies gained higher average scores in Atoms and Molecules Concept Test than students instructed by traditionally designed instruction . In addition , students in experiental group indicated a higher positive attitude toward chemistry as a school subject .The results also indicated science process skill was a stronger predictor for the achievement of atoms and molecules concepts.

Strategies that were developed and results obtained for the present study may be used by science teachers to eliminate the students' misconceptions about atoms and molecules concepts and provide better conceptual understanding of atoms and molecules.

KEYWORDS : Conceptual Change Text Oriented Instruction Accomoanied with Analogies , Traditionally Designed Chemistry Instruction, Misconception, Attitude Scale Toward Chemistry as a school subject, Science Process Skills.

ÖZ

ATOM VE MOLEKÜLLERLE İLGİLİ KAVRAMLARI ÖĞRENMEDE KAVRAMSAL DEĞİŞİMİN KOLAYLAŞTIRILMASI

GÜNAY ,Barış
Yüksek Lisans, Orta Öğretim Fen ve Matematik Alanları Eğitimi
Tez Yöneticisi: Prof. Dr. Ömer GEBAN

Ocak 2005, 100 sayfa

Bu araştırmanın amacı,benzetmelerle ve aktivitelerle desteklenmiş kavramsal değişim metinlerine dayalı öğretimin lise 2.sınıf öğrencilerinin atom ve moleküller konusunu anlamalarına,kavram yanılgılarını azaltmalarına ve kimya dersine olan tutumlarına etkisini incelemektir.

Çalışmada aynı kimya öğretmenin eğitim verdiği 45 lise ikinci sınıf öğrencisi yer almıştır.Çalışma Elmadağ Lisesinde 2004-2005 öğretim yılı sonbahar döneminde gerçekleştirilmiştir.

Çalışma için iki grup oluşturulmuştur.Deney grubunda, atom ve moleküller konusu işlenirken benzetme ve aktivite destekli kavramsal değişim metinleri kullanılmıştır. Kontrol grubunda ise geleneksel kimya öğretim metodu kullanılmıştır.Öğrencilerin atom ve moleküller konusundaki başarılarını belirlemek için atom ve moleküller kavramları testi uygulanmıştır.Öğrencilerin kimya dersine olan tutumlarını belirlemek için kimya dersi tutum ölçeği kullanılmıştır.Öğrencilerin bilimsel işlem becerilerini ölçmek için ise bilimsel işlem beceri testi uygulanmıştır.

Çalışmanın hipotezlerini test etmek için Varyans analizi ve Ortak Değişkenli Varyans Analizi istatiksel analiz yöntemleri kullanılmıştır. Analiz sonuçları benzetme destekli kavramsal değişim metinlerini kullanan öğrencilerin atom ve moleküller konusundaki başarılarının geleneksel kimya öğretim metodunu kullanan öğrencilere göre daha yüksek olduğunu göstermiştir.Ayrıca, benzetme destekli kavramsal değişim metinlerini kullanan öğrencilerin kimya dersine olan tutumlarının pozitif yönde geliştiği gözlenmiştir.Analiz sonuçları, bilimsel işlem becerisinin , öğrencilerin atom ve moleküller ile ilgili kavramları anlamalarını etkileyen önemli bir faktör olduğunu göstermiştir.

Bu araştırma sonuçları ve geliştirilen yöntemler bakımından araştırmacılara ve kimya öğretmenlerine katkı sağlayabilir.

ANAHTAR SÖZCÜKLER: Benzetme Destekli Kavramsal Değişim Metinleri, Geleneksel Kimya Öğretim Metodu, Kavram Yanılgısı, Bilimsel İşlem Becerisi, Kimya Dersi Tutum Ölçeği

ACKNOWLEDGEMENTS

I would like express my deepest gratitude to Prof Dr. Ömer Geban, the supervisor of my thesis for his continuous encouraging efforts, advice and criticism throughout the study.

I would like to thank to Önder Özgen who applied my teaching methods in her classroom.

LIST OF SYMBOLS

SYMBOLS

t : statistic

p: Observed Significance Level

SS: Sum of squares

df: degrees of freedom

MS : Mean square

F : The ratio of two mean squares

n: number of sample observed

$\overline{X}$: Mean of the sample

s: Standard deviation

LIST OF FIGURES

FIGURES

LIST OF TABLES

TABLES

LIST OF ABBREVIATIONS

ABBREVITATIONS

EG	: Experimental group
CG	: Control Group
AMCT	: Rate of Reaction Concepts Test
ASTC	: Attitude Scale Towards Chemistry as a school subject
SPST	: Science Process Skills Test
CCTOI	: Conceptual Change Texts Oriented Instruction Accompanied with Analogies
TDI	: Traditionally Designed Chemistry Instruction

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

Learning is an personel action that occur in a student's mind . It sometimes appears to be a very simple action , because we don't realize how it occurs through the daily life . The numerous of learning theories and definitions try to f'nd out how this process take place and what precise learning is . For instance; the autors states that learning implies a change in the individual as a result of some intervention .It may be viewed as an outcome, or a process (Belkin and Gray, 1977). Here , this point of view describes the learning as an outcome in a behaviorist way, but many other learning theories perceived this definition as a startig point and they discovered diffrent point of views that describe the ways of defining learning. These point of views include various factors having the ability to trigger learning to occur in dstudent's mind .

Constructivism is the one of the most popular one among the learning theories. It is a philosophy of learning that refers to the idea that learners construct knowledge themselves .Each learner individually (and socially) constructs his/her meaning as he or she learns (Hein,1991).According to this philosphy of learning , students are constructing their own knowledge by testing their own ideas and approacches which are based on the their previous knowledge and experiences , applying these to new situations, and integrating the new knowledge with pre-existing intellectual constructs .

Constructivist learning views have been documented by the different researches and studies . For example; Bloom ,Perlmutter and Burrrel (1993) defined Constructivism as a receptive act that involves construction of new meaning by

learners within the context of their current knowledge, previous experience , and social enviroment . Spigner , Littles and Anderson (1999) suggested that real life experiences and pervious knowledge are the stepping stones to constructivism .

Many constructivists believe that knowledge also may be socially constructed by learner even if they construct their meaning individually, because knowledge may be constructed by the fact that public knowledge. In other words, ideas and information are stored and made avaiable for the general public. One of the main contributors of constructivism, Lew Vgotsky stated that students need socially rich environment in which they explore subject with teachers and peers. Because a child learns to construct the essential meanings of signs aand symbols through social interaction with adults in the culture .In addition the cultural context ,the associated language and other symbols have the abilty to affect a child's perception of the natural phenomena .

Many science concepts require difficult thinking changes for students and special instructional techniques to asist and guide students in their learning (Anderson and Roth, 1988; Carey,1986 ; Glaser ,1982 ; Posner ,Strike, Hewson, and Gertzog ,1982) .Most of students have some difficulties in learning science courses ,because they have some hazy ideas (Nakhleh,1992) and preconceptions (Anderson and Smith,1983). At the same time, science courses which include some concepts and theories conflict with the scientific understanding of students , because , according to the most popular opinions , learning in science entails more than just adding new concepts to knowledge . Science learning often requires realignment in thinking and construction of new ideas that may conflict with earlier ideas (Fellows , 1994). These conflicting conditions in stuent's mind cause conceptual classroom to be more difficult . Therefore, it is essential to develop the ways of improving conceptual understanding in order to provide meaningful learning .

Students always have interaction with natural world and observe the phenomena ocurring through the natural world and always talk to other people about

their experiences and ideas . In addition , when they encounter natural phenomena in the world , they develop rudimentary explanations and generalize their own mental models about phenomena including science matters . All of these cause conflicting conceptions and ideas that lead to difficulties in understanding science concepts.

Such misunderstandings and difficulties have been defined as misconceptions (Fisher ,1985) , alternative frameworks (Driver and Easley ,1978) , intuitive beliefs (Mc Closkey ,1983), preconceptions (Anderson and Smith ,1983) ,spontenous reasoning (Viennot ,1979), children's science (Osborne , Bell ,and Gilbert ,1983) and naive beliefs (Caramazza , Mc Closkey , and Green ,1981) . In this present study , the term misconception will be defined as by Cho, Kahle and Nordland (1985) to state any conceptual idea whose meaning deviates fron the commonly accepted by scientific concensus.

Misconceptions are often strongly resistant to traditional teaching and form coherent ,though mistaken, conceptual structures (Driver and Easley,1978) .Learning difficulties , misconceptions , or everyday conceptions can be triggered by daily life experiences ,reading books or consumption of mass media .Nieswandt (2000) suggested that everyday conceptions are not simply personal views of the world , but reflect a shared view represented by a shared language . This shared view constitutes a socially constructed common sense's way of describing and explaning the world (Driver et al . , 1994) But some researchers (Anderson and Smith, 1983 ; Osborne and Freyberg ,1985) have convincingly demonstrated that young students can indeed e helped to construct accurate conceptions .

When students come to class , they bring to instruction a variety of conceptual frameworks that are often at odds with scientific ideas (Anderson and Smith ,1987 ; Driver and Erickson,1983) .These conceptual frameworks constitutes their real vorld conceptions . Students's real world conceptions play a critcal role in their views of the world (Nusbaum and Novick , 1982). The real world conceptions or prior knowledge have important effect on the learning .

During instrction , they choose the information to which they can give their own meaning based on their previous conceptions .(Nieswandt, 2000). Nakhleh (1992) suggested that the brain actively interprets this selected information and draws inferences based on its stored information. That's why , students' existing conceptual frameworks and previous conceptions must be reorganized , rearranged , or replaced with the newly structured schemas and new concepts . Piaget (1950) described such changes as accommodation. A learner's schema does not fit with new information so the learner must adjust existing schemas and create new connections to make sense of the new information. The process that reorganizing , or replacing existing conceptions to accomodate new ideas is defined as conceptual change by Smith et. al. (1993). Conceptual change process overcomes misconceptions which arising from student's prior knowledge or student's real life conceptions . Posner ,Strike , Hewson , and Herzog (1982) propose the model of conceptual change which suggests four conditions must be satisfied for conceptual change . These are ;

1) Student must dissatisfy with existing concept ,
2) Anew concept must be easily understand (intellegible),
3) New concept must be plausible ,
4) New concept must be fruitfull.

Some researchers (Anderson and Smith ,1987 ; Carey ,1985 ; Posner et .al , 1982 ;) describe the evidence of conceptual change as radical changes in thinking , where studets' core concepts , principles , and theories change the organization of their scemas . However all these require the need both skillful , knowledgeable instruction by the teacher and active participation and cognitive struggle by the students . A lot of teaching strategies have been sugested to promote conceptual change . Nusbaum and Novick (1982) suggested a teaching strategy including two separate parts where students are made aware of their own relevant prior conceptions and then engaged in conceptual conflict triggered by a discrepant event (Driver et .al . 1992) . Anderson et.al. (1987) suggested a teaching strategy

which elicits aand responds students' misconceptions , focuses on explanations, probes studens responses, balances open ended and closed discussions ,and provides practice and application. Likewise , many suggested teaching strategies follow the similar ways that satisfy four conditions to promote conceptual change desbribed above .

Some strategies are conceptual change texts, refutational texts, and analogies which are used to facilitate conceptual change process . Conceptual Change text , also called refutational text , is the one of aids addressing misconceptions and fostering conceptual change process. The superior characteristics of this type text is to choose the misconcteptions as a target to promote conceptual change process. In a study conducted by Sungar et. al.(2001), conceptual change texts presents information illlustrating inconsistencies between common misconceptions and scientific knowledge . At the same time, it has a function of increasing amount of social interaction between students and the instructors .

Salisburg – Glennon and Stevens (1999) suggested that generally a conceptual change text adresses reader's naive conceptions by contrasting them with more scientifically accepted canceptions . In another study, Kim and Van Dunsen (1998) state that such text provided elaborations have been found espacially helpful in the absence of relevant background knowledge with which the new information could be linked .

On the other hand , analogies have an important role in meaningful learning and to facilitate conceptual change . They take a role as an inspriation . To introduce non observable entities like atoms and molecules to students , teachers and textbook writers are constrained to introduce analogies, analogical models, and representational models like chemical formulas and chemical equations (Harrison and Treagust ,1996) .

When an analogy is used in instruction , students use the similarities between

a familiar one and unfamiliar one . Analogies in a text can helpful to build meaningful relations between what students already know and what they are setting out to learn .

Morover , they provide not only conceptual understanding of science , but also provide quick learning . In this way , Goldblum (2001) concluded that human learns more quickly when they can make connections, or analogies , between current knowledge and new knowledge .

This study compared the effect of conceptual change texts oriented instruction accompanied with analogies over the traditionally designed chemistry instruction. The present study, the main aid of conceptual change based instruction was to activate the students' misconceptions related with atoms and molecules .

CHAPTER 2

REVIEW OF RELATED LITERATURE

Understanding of chemistry is difficult for students , because chemical concepts and phenomena cannot be understood by merely giving examples related to these concepts and phenomena to students , because it is not possible to merely show the real images of atoms , molecules and ions , compounds in the classroom. Nieswandt (2000) stated that physical and chemical changes are visible as changes of the state of matter or changes in other properties of the substance like colour. But in spite of this fact ,Several studies have reproted that secondary students don't grasp these chamical concepts (Anderson ; 1990 ; Bou Jaude ,1991).At the same time , students may misinterpret the knowledge during the instruction so that they might have some difficulties to learn the concepts and the relationships between these concepts regarding chemistry. Because , what they seem to do is to memorize facts and terminology without changing their theories about how the world works. (McCloskey,1983).Furthermore, they rarely accomplish the conceptual understanding . Because , when they are asked to describe , explain , or make predictions about the real world phenomena , students find their memorized facts and algorithms useless and return to their familiar real world conceptions (Fellows,1994) . The real world conceptions occurs in students' mind through their daily life . However , most of the learning difficulties and misinterpretations are caused by daily life experiences . Therefore , the prior knowledge and conceptions which were gained as a result of individual experiences in life influences directly students' learning . Moreover , individual experiences are many and varied . The influence of this prior knowledge on learning varies from student to student (Harrison and Treagust , 1996) In addition , Prior knowledge and experiences create different meanings of a concept ranging from entirely correct to entirely incorrect. Acquisition of knowledge to provide meaningful learning and understanding

concepts are not simply addition of new knowledge to current knowledge . Smith et al. (1993) suggested that meaningful learning of science involves coming to understand scientific ideas as they are used for their intended purposes , including description , prediction and explanation of phenomena in the natural world .

Taylor (1993) has explained the acquisition of knowledge as a view of human knowledge as a process of personel cognitive construction , or intervention , undertaken by the individual who is trying , for whatever purpose , to make sense of her social or natural enviroment . Duit (1996) explained it as personal construction by the individual . Each individual build her own knowledge based on her prior knowledge and early experiences .During this process ,each concept is built from another one so that all concepts are combined cognitively in student's mind . As a result , student establish the meaningful undersatnding in her mind . By creating meaningful links between the concepts acquired in a chemistry course , meaningful learners may reduce memory overload and increase the amount of information they process simultaneusly. Consequently, these learners may improve their ability to correct misunderstandings and solve problems (Boujaoude,1992) .

On the other hand, Smith et al. (1993) stated that science teaching needs to develop conceptual understanding rather than rote memorization or avoiding conceptual issues in favor of procedures and activities . In addition , an important goal of science teaching is to assist students as they come to understand improtant scientific concepts and relationships (Fellows ,1994). Therefore , rote learning or simple addition of new knowledge to current knowledge are not enough to promote meaningful learning of science .

The concepts of atoms and molecules have been fundemental parts of the learning chemistry courses . Understanding these concepts has a substantial effect on leaarning other concepts of the chemistry . At the same time, students have many difficulties to describe and understand properties of invisible atoms and molecules

and explain changes of state of matter in terms of atoms and molecules . That's why , it is essential to define and describe misconceptions related to the atoms and molecules before implementing the instruction which includes the special instructional techniques to be designed to make students understand that scientific conception is more useful than the pre-existing conceptions in student's mind . Therefore, this study is primarily concerned with students' misconceptions about aatoms and molecules and the effect of conceptual change based instruction on understanding concepts of atoms and molecules .

2.1.Misconceptions

Findings consistently report that students have great difficulty explaining the nature of substances and observable changes of substances (Bar, 1989; Osborne and Cosgrove, 1983 ; Stavy , 1988 ; Stavy and Stachel , 1985a) . During the past two decades, research on the role of studets' preinstructional knowledge , misconceptions (Driver and Easley , 1978), preconceptions (Driver and Easley ,1978), alternative frameworks (Driver and Erickson ,1983), or children science (Osborne and Freyberg ,1985) showed that these notions limited studets' understanding in science and are often different from the commonly accepted scientific concepts (Nieswantd, 2000).

Misconceptions are created by different sources . Griffiths and Preston (1992) stated that they may arise prior to formal instruction as a result of the variety of contacts students make with the physical and social world (Strauss, 1981), or as a result of interaction with teachers (Gilbert and Zylberstajn , 1985), or from textbooks (Cho et.al., 1985).

One misconception can be created individually created by misinterpreting the previous concepts, or it can be supported by through daily life experiences .Out of these accumulated experiences , students can develop rudimentary explanations or develop mental models of many natural phenomena inculding different topics such as life, astronomy, light , force, matter (Harrison and Treagust, 1996). These

rudimentary explanations constitutes children's science (Duit and Teragust, 1995 ; Gilbert, Osborne, and Fensham,1982)which causes students to create misconceptions .

Misconceptions are generally firmly established in student's schemata , thus , reluctunt to transform (SungUr ,Tekkay , and Geban ,2001) and students' learning difficulties often persist even after formal instruction in science classes. As correcting the misconceptions, the new and scientific conception must be incorporated into the preexisting schema involving the misconceptions .This incorporation was described as discontinuous paths and continuous pathways by Duit (1996). The first of which emphasizes that the Cognitive Conflict which is used to start changing the misconceptions to the scientific conceptions .Duit (1996) suggested that cognitive conflict strategies play a key role in all approaches that fall into the this category . Students are engaged in cognitive conflicts triggered by a discrepant event (Scott , Asoko , and Driver , 1992) . The cognitive conflicts force the student to construct new schemas and to subsume in a more differentiated way , old and new experiences (Nieswandt, 2000). By presenting dicrepant event, the students are able to realize the faulty connection and find out why and how the new concepts are more useful .

However , continuous pathways start from aspects of students' conceptual structures that are already mainly accord with the science conception with developing a kernel harmony between the conception of departure and the target conception (Duit , 1996).

2.1.1 Misconceptions in Atoms and Molecules

This present study focuses on Grade –10 students's understanding the nature of atoms and molecules . Chemical educators agree that understanding the concepts of atoms and molecules give a fundemental base for the learning of chemistry

(Griffiths and Preston,1992).Gabet et. al. (1987) investigated that many students are not constructing appropriate understandings of fundemental chemical concepts from the begining of their studies . Therefore , they cannot fully understand the more advenced concepts that are build upon the fundementals (Nakhleh, 1992).

Griffiths and Preston (1992) investigated 30 grade-12 Canadian students' understanding of the concepts an atom and a molecule .They identified 52 misconceptions including categories such as the structure, shape, size, weight atoms and molecules. They reported that at least one-half of students shared 6 misconceptions including overestimation of molecular size, and the beliefs that molecules of the same substance may vary considerably in size; that molecules change weight when a substance change its phase ; and that atoms are alive . They also reported that at least one-third or more of the sample shared some the misconceptions included the beliefs that ;

- water molecules are composed of two or more solid spheres ;
- molecules change in size when a phase change occurs ;
- water molecules are heavy enough to be directly weighed and change weight when changing phase ;
- water molecules are not all compoesd of the same atoms but rather contain other components and may contain more than three atoms ;
- molecules change shape with tempurature change ;
- solid matter is continuous ;
- matter exists between atoms of pure element
- atoms are alive because thay move .

Osborne and Freyberg (1985) in their research observed that students , even after instruction , are still confused about the multiplicity of terms they have been exposed to, for example, particles, atoms, molocules, and nuclei – and their relations.

In another study ,Lee , Eichinger,Berkheimer and Blakesle (1993) conducted a study to understand the conceptual frameworks that sixth-grade students use to explain the nature of matter and molecules, to assess the effectiveness of two alternative curriculum units in promoting students' scientific understanding.This study involved 15 sixth-grade science classes taught by twelve teachers in each two successive years and data collected in the study was obtained through paper and pencil test and clinical interviews . The results of the their study showed that there are some differences between the students' entering conceptions and scientific conceptions interms of molecular conceptions concerning nature of matter as well as macroscopic conceptions concerning nature of matter.Likewise , Brook , Briggs ,and Driver(1984) conducted a study indicated that students have a tendency to transfer changes in macroscopic properties to the microscopic level .

Ben-zevi , Eylon , and Silberstein (1986) investigated 300 grade –10 students' beliefs about atoms after exposing to a chemistry study for almost half a year. There was a diagnostic investigation of students' ideas about atoms in their study and also development ,implementation and evaluation of a program was designed to prevent misconceptions identified in the diagnostic investigation .In order to identify misconceptions, a quetionnaire was applied to eleven 10-grade students in different high schools from Israel . They observed that nearly half of the students believed that the bulk properties of the substances such as color , electrical conductance , malleability were also properties of a single atom. In the second stage of their study , they developed a technique based on the development of the atomic development and concluded that this technique is effective to prevent some of the misconceptions .

Harrison and Treagust (1996) conducted a interview based study probed 48 grade 8-10 from students' mental models of atoms molecules . They found that many students preferres the models that are both discrete and concrete . They found the miconceptions such as electron shells are the shells that enclosed and protected atoms while electron clouds were the structures in which electrons were embeded .In

their study , they concluded that language used in the class and discussion during instruction are the major source of the alternative conceptions .

However , students may have tendency to show misconceptions about individual atom and its constituents. For example; Sandmir, Stahl, and Verdi (1993) conducted a study which probed student conceptions of the metephor '' an atom is an electron cloud '' and '' an atom is an electron shell '' and indicated that students are not able to recognize where the metephor breaks down .In addition ; Griffiths and Preston (1992), identified misconceptions about atom's constitutents held by the students such as ''Electrons have no mass , just a change '' , '' All the atoms in a molecule are the same '' , '' There is only one kind of atom '' , and '' Protons have a mass of one gram '' .

2.2. Conceptual Change and Conceptual Change Texts

Learning is an active process in which students play an active role and construct her knowledge based on her previous knowledge , ideas or experiences . During this learning process , students create their own personal meanings and the conceptual schemes which are based on prior knowledge and experiences.

However, it is possible to misinterpret the new knowledge, or create misconception, due to previous knowledge, experiences, or learning environment .In order to eliminate inaccurate knowledge and misconceptions and support conceptual understanding , teachers need to develop conceptual change activities. A conceptual change view of learning science sees students taking an active role in building their own knowledge by modifying their existing conceptions through the process of conceptual change (Posner et.al. , 1982). Posner et . al . suggested four conditions of the conceptual change process to be occured in student's mind . These are ;

a) Students must feel dissatisfaction with their previous concepts,
b) the new concept must be intelligible ,

c) the new concept must be plausible,

d) the new concept must be fruitful .

When satisfying these four conditions , the conceptual change process occurs and this process help students to understand and use the concepts and the conceptual-schemes of science which are complicated by the misconceptions and inaccurate scientific knowledge .

Conceptual change involves techniques of accomodation, restructuring, replacing, or reorganizing a concept (Taylor, 2001). Different models have been developed to foster conceptual change. One of them is conflict based model which confronts students with discrepand events that contradict their existing conceptions . In these models, cognitive conflict strategies play an important role to eliminate misconceptions and inaccurate knowledge. There are three primary sources of cognitive conflicts. First, the cognitive conflict is created by the student's predictions and contrasting these predicitons to the experimental results. Second, it is generated by contrasting the ideas of the student and those of teacher . Third, cognitive conflict is created by making student feel that there is a conflict among her beliefs (Duit , 1996). In their studies, Hewson and Hewson (1984) found that the conceptual conflict was effective in changing students' alternative conceptions . In additon, Guzetti, Snyder, Glass, and Gamas's (1993) concluded that succesful techniques often included attempts to cause conflict between non-scientific and scientific explanations to trigger dissatisfaction with the non-scientific ideas in student's mind .The conflict based models have such a structure that indicate the four conditions for conceptual change; dissatisfaction, understanding, plausibility , and fruitfulness . Firstly, there must be a dissatisfaction with a present notion when the discrepant event is presented. The new idea or knowledge must be more understanable than the previous knowledge or idea . In additon to this, the new idea must also be plausible. It must precisely connect with the current cognitive framework of the concept and related ideas and must be believable. And the new

idea should be fruitful and influence new inferences and produce capabilities for expansion and generalization to new idea and concepts (Sungar et. al., 2001).

In Piagetian Point of view, a mental disequilibrium occurs in student's mind and this demands an interplay between assimilation and accomodation until equilibrium is restored (Dykstra ,1992 ; Rowell and Dawson , 1985) .

However, other models bring different persfectives to conceptual change process. Fensham et . al. (1994) suggested that conceptual change is rarely an abrupt change, but more often an accretion of information and instances that the learner uses to sort out contexts in which it is profitable to use one form of explanation or another . Since the previous ideas are not aboned incrementally, this process called as conceptual addition .

Dykstra, Boyle, and Monarch (1992) brings different view of conceptual change process. In their study , they asserted that conceptual change is a prograssive process of refinement of students' conceptions and propose a taxonomy of conceptual change including differentiation, class extension and reconceptualization. Niedderer and Goldberg (1994) see a similar prograssive development for conceptual change which is a change from the learner's prior conceptions to some intermediate conceptions and to scientific conceptions.Duit (1996) described learning as a change from one concept to another , or literally , an exchange of concepts . On other hand , Hewson and Hewson (1992), in their study , concluded that a change doesn't mean exchange (i.e replacement), they described it as changing status of conceptions. Here, learning science means that students give less status their misconceptions and give higher status to scientific conceptions accordingly.

Conceptual change text , or refutational text , is the text that identifies and analyses misconceptions, then refutes them and non-scientific ideas which can be created in students' mind. It supports conceptual change process, because it

illustrates inconsistencies between common misconceptions and scientific knowledge and indicates the usefulness and plausibility of scientific knowledge within its text structure .Such text provided elaborations have been found particularly helpful in the absence of relevant background knowledge with which the new information could be linked (Kim and Van Dunsen, 1998). A large number of studies have been conducted to investigate effects of conceptual change text on students' conceptions .Hynd et. al .(1994) used a refutational text about Newton's Laws of motion for ninth and tenth grade students and found that 52 % of the students revised their conceptions.Chambers and Andre (1997) wanted college students to read a conceptual change text about electricity in order to investigate the relationship between interest and experience in electricty, gender, and conceptual change text manipulations on learning fundemental direct current concept. They concluded that conceptual change text led to a better conceptual understanding.

Guzetti, Snyder, Glass and Gamas (1993), in their research, found that refutational text was more effective than regular or traditional text for conceptual change , and concluded that these texts are, at least, more effective to support conditions suggested by Posner, Strike, Hewson and Gertszog(1982) .

There are many other researches that investigate the effects of conceptual change text different science courses. Sungur et.al. (2001) tried to determine the results of promoting conceptual change through the use of conceptual change text and concept mapping . The result of the study indicated support for facilation of environment consisting of debate, discussion, and increased participation.The students realized and became dissatisfied with their misconceptions and were more receptive to the new correct information. They realized the new concept was more meaningful through the active involment .

Geban and Bayır (2000) conducted a research to investigate the effectiveness of conceptual change texts instruction over the traditionally designed chemistry instruction on students' understanding of chemical change. 50 nineth grade students

from two clases in METU Private High School participated the study. The result of the study showed that students in conceptual change text instruction group had a significantly higher score with respect to achievement than the students in the traditionally designed instruction group.

Çakır et .al.(2002) compared the effects of concept mapping and conceptual change texts instruction over the traditional instruction on tenth grade students' understanding acid and base concepts . There were 110 students from six classes who enrolled the study . Two experimental groups class were instructed with concept mapping instruction, other two were instructed with conceptual change text instruction and two control group students were instructed with traditional instruction. All these students were administrated the acid –base concept pre-test and post-test. The results of the study showed that caused a significantly better acquisition of scientific conceptions related to acids and bases than the tarditional instruction.

Moreover, the effects of a conceptual change text can be increased when it is used with different instructional techniques, or activities. Alverman et.al. (1995) obtained more pronounced effects when a refutational structure presented with a supportive activity, such as small group discussion after reading .

2.3Analogies

Analogies are useful tools to provide conceptual growth in science teaching. They consist of three components : the Target (or source) is the new knowledge or concept which is being studied, the Analog which is the similar concept or model being compared, and third component is the mapping which includes the relationships between the target and analog (Krawczyk, Holyoak and Hummel, 2004 ; Rule and Furletti ,2004). Clement(2002) stated that an analogy isolates elements of situations and so that these elements can be put in a correspondence . Within this

correspondence , elements from two separate domains may be quite different , but structional relatinships exist between them (Yanowitz,2001).

Analogies are commonly accepted as a supportive tool which is used to facilitate conceptual change and overcome misconceptons to provide the conceptual understanding . In so doing ,they help students make connections between the new concept and previous learning and provide a way of organizing information around the relationships and ideas so that they can more easily grasp the new knowledge (Rule and Furletti ,2004). An analogy also plays a generative role,espacially when used in situations for which prior knowledge is poorly organized and incomplete (Coll and Treagust, 2002). Furthermore, analogies can engage students in a high level of thinking skill, because creating a systematic correspondence from two separate domains requires analytical and creative thinking skills (Clement ,2002).

Motivation and interest are essential ingredients in effective learning (Harrison ,1992), and these ingredients have two important factors to promote conceptual change .Palmer (2003) concluded that the motivational factors have direct relation to the effect of a conceptual change strategy and Thagard (1989) claimed that motivational factors enhance the conceptual change. Analogies provide the interest level of science topic and motivation for students. Therefore, using analogies in science instruction, it will lead to result in meaningful learning .

Duit (1991) overviewed 15 years research (emprical as well as analytical) on analogy and concluded that the role of analogies and metaphors in science must be considered to be an essential aspect of science instruction if the science instruction should not only teach scientific knowledge but also metaknowledge .Dagher (1994) examined the contribution of analogies to conceptual change and how the analogies facilitate conceptual change process. In this way he reviewed three studies which examined analogies and conceptual change . The selection of the these studies was

based on four main reasons: a) their purpose which addreses the connection between analogies and conceptual change; b) their involving teacher – students interactions in istructional environment; c) diverse methods for data collection in the studies; d) being conducted in a recent time .He discussed that analogies may provide students with the level of comfort and security that enables them to connect their world to the world of theories of abstractions. Therefore, In his study, he concluded that the examining the the role of analogies in relation to conceptual change is not enough at the level of examining the students' understanding, but it includes their contribution to the psychological factors of learning .

Harrison and Tragust (1994) tried to enhance the conceptual understanding while simultaneously reducing the probable misconceptions in their study. In this way ,they suggested a model by modifying the model called as Teaching With Analogies which was developed by Glynn (1991) and used it with an analogy about hypothermia in their study. At the end of the study, they concluded that presenting the analogies with a systematic teaching model has the potential to enhance student understanding of science concepts while simultenously reducing the probable misconceptions.

Gabel and Samuel (1986) conducted a study to determine the effects of analogies when solving molarity problems. Results of the study indicated that students' achievement in certain molarity problems might be improve by using analogies if students saw the connection between analog and target concepts.

Yanowitz (2001) conducted a study that included two experiments . In first one, students taught with analogical text and other students taught with an expository text about cells and their components .Then, students were asked to recall the text and answer the inferential questions. The second experiment was performed with different students who read an analogical text once and a non analogical text was read twice for the second group of students. As in the first experiment, students were asked to recall the text and answer the inference questions. In both of the

experiments of the study, students who received the analogical text were able to demonstrate a better inferential reasoning. She concluded that the analogies in the text seemed to help evevn the younger elementary school students develop a deeper understanding of the domain than they would have gained without the analogy .

Harrison (2002) reviewed the five researches to examine affective aspects of analogies . The researches reviewed in this study were selected because of the evidence indicated that they were found as interesting by the students who participated these studies. Teaching took place within these five studies was in the middle school science, chemistry and physics classes.In his study , he concluded that familiar analogies have the ability to interest and excite students, but not all of them. He emphasized that teachers need to have analogy resources and an alternative analogy in case of being ineffective when using the analogy and also concluded that careful planning and knowing the limits of analogy used in the class are other important factors for effective using of analogies .

Else and Clement (2003) conducted a study that analyze the a subset of analogies used to help middle school students understand cellular respiration and the body systems asssocited with it . They also characterized the students' learning to determine analogy success and the types of students' errors when learning by analogy so that they made connections analogy features and learning difficulties . After conducting the study, they concluded that learning through analogy can be a complex process and may not be effcective if an analogy uses a base that is familiar to students or if elements of the analogy are complex . They empasized that students need metacognitive awereness for learning by an analogy.

The present study tried to compare the effects of conceptual change based instruction including a conceptual change text ,analogies and activites. Futhermore,a multiple choice test was applied to the students in order to identify the students' misconceptions and misunderstandings about atoms and molecules in chemistry .

CHAPTER 3

PROBLEMS AND HYPOTHESIS

In this part, the main problems, sub-problems and hypotheses will be presented.

3.1 The Main Problems and the Sub-Problems

3.1.1. The Main Problem

The main aim of this study is to examine the effectiveness of conceptual change texts oriented instruction accompanied with analogies over traditionally designed chemistry instruction on 10^{th} grade students' understanding of rate of reaction concepts and attitudes towards chemistry as a school subject.

3.1.2 The Sub – Problems

1. Is there a significant difference between the effects of traditionally designed chemistry instruction (TDI) and conceptual change texts oriented instruction accompanied with analogies (CCTOI) on students' understanding of rate of reaction concepts when the effect of students' science process skills are controlled as a covariate ?

2. Is there a significant difference between the girls and boys with respect to their understanding of rate of reaction concepts when the effects of students' science process skills are controlled as a covariate?

3. Is there a significant effect of interaction between gender and treatment on students' understanding of rate of reaction concepts when the effect of students' science process skills are controlled as a covariate?

4. What is the effect of students' science process skills on their understanding of rate of reaction concepts?

5. Is there a significant difference between the effects of TDI and CCTOI on students' attitudes toward chemistry as a school subject?

6. Is there a significant difference between girls and boys with respect to their attitudes toward chemistry as a school subject?

7. Is there a significant effect of interaction between treatment and gender difference on students' attitudes toward chemistry as a school subject?

3.2 Hypotheses

In this study, the following hypotheses were developed related with problems to find solution. All hypotheses were stated in null form at a significant level of 0.05.

H_o1: There is no significant difference between post-test mean scores of the students taught with TDI and those taught with CCTOI with respect to their understanding of rate of reaction concepts when the students' science process skills are controlled.

H_o2: There is no significant difference between post-test mean scores of girls and boys with respect to their understanding of rate of reaction concepts when the students' science process skills are controlled.

H_o3: There is no significant effect of interaction between gender and treatment on students' understanding of rate of reaction concepts when the effect of students' science process skills is controlled.

H_o4: There is no significant contribution of students' science process skills to the variation on their understanding of rate of reaction concepts.

H_o5: There is no significant difference between post-test mean scores of the students taught with TDI and those taught with CCTOI with respect to attitudes toward chemistry as a school subject.

H_o6: There is no significant difference between boys and girls with respect to their attitudes toward chemistry as a school subject.

H_o7: There is no significant effect of interaction between treatment and gender difference on students' attitudes toward chemistry as a school subject.

CHAPTER 4

DESIGN OF THE STUDY

4.1 The Experimental Design

In this study, Non-Equivalent Pretest-Posttest Control Group Design was used to evaluate students' development.

Groups	Pre-test	Treatment	Post-test
EC	AMCT,ASTC,SPST	CCTOI	AMCT,ASTC
CC	AMCT,ASTC,SPST	TDI	AMCT,ASTC

Table 4.1 Research Design of the Study

In this table , EC and CC represented the groups which are the Expremental Group and Control Group respectively.During the study , the experimental group was instructed by conceptual change text oriented instruction (CCTOI) accompanied with the analogies whereas the control group was instructed with the traditionally designed instruction (TDI). AMCT was the Atoms and Molecules Concept Test, ASTC was the attitude toward chemistry as a school subject and SPST was science process skill test, all of them were administrated both experimental and control groups .

In the first case, AMCT,ASTC,SPST were administrated both of groups before begining the treatment in order to investigate the effectiveness of treatment on dependent variable, and also to determine the students' understanding of atom and molecules related concepts, attitudes toward chemistry and the level of science

process skills .After the treatment , AMCT and ASTC were administrated to both of the groups at the end of the treatment.

4.2 Subjects of The Study

In this study 45 10^{th} grade students from the Elmadağ Lisesi which was instructed by same chemistry teacher . This study was carried out during 2004-2005 fall semester.

In this study, two instructional methods were used and these methods were randomly assigned to each group. Experimental group was instructed with CCTOI while control group received TDI. Experimental group was composed 23 students and control group was composed of 22 students.

4.3Variables

Two types of variables which are dependent and independent were used in this study .

4.3.1. Dependent Variables

Students' understanding of atoms and molecules related concepts evaluated by AMCT and students' attitudes toward chemistry as a school subject evaluated by ASTC were the dependent variables in this study.

4.3.2. Independent Variables

Treatment (CCTOI and TDI), science process skills scores measured by SPST and genders are the independent variables in this study.(see Table 4.1.).

Table 4.2. Types of Variables

Variables	Type
AMCT Scores	Dependent
ASTC Scores	Dependent
Treatment (CCTOI and TDI)	Independent
SPST Scores	Independent
Gender	Independent

4.4 Instruments

4.4.1 Atoms and Molecules Concept Test (AMCT)

Atoms and Molecules Concept Test was designed by researcher in order to investigate the students' understandings and misunderstandings about atoms and molecules and their related concepts. It contains 25 multiple choice items and each of them includes five alternative choices.Distractors which represent the misconceptions are also avaiable among the five alternatives of the each question. The concepts used in the test to search the misonceptions of students can be underlined the following content- outline :

1. Structure of an Atom
   i.Movements of Electrons
   ii.Protons and neutrons
2. The Weight of An atom and Molecule
3. The Size of An Atom and Molecule
4. Energy of Atoms and Molecules
5. The Composition of Molecules
6. The Shape of Atoms and Molecules

The questions in the test are mainly developed as qualitative in order to determine the possible misconceptions of students .Therefore , it can be expected to be determined misconception or misconceptions about atoms and molecules for the students who give the wrong answers or predictions .

During the construction of the test ,content of atom and molecules' related concepts was examined and then instructional objectives were stated . (See Appendix B). Firstly, Students' misconceptions were searched in the internet resources and also chemistry education literature. Then, questions of the test were developed according to these misconceptions and the previously determined instructional objectives.

Misconceptions	**AMCT Item No**
I. Structure of an Atom	
a- An are alive	22a
b- Electrons move in orbits	2b,7b, 21b,24b ,8b
c- Protons	3c
II. The weight of atoms and molecules	
a- All atoms have the same weight .	4a
b- The weight of atoms and molecules depend on what phase they are in .	5b 15b
III- The size of atoms and molecules	
a- Atoms are large enough to be seen under a microscope .	1a , 9a , 11a
b- All atoms have the same size	6b ,25b
c- Atoms are larger than molecules	11c , 25c
d- The size of molecucles depends on what phase they are in	14d
e-Heat causes molecules to expand	13e ,20e

Table 4.3. Classification of students' misconceptions

Table 4.3.continued

IV- Energy of atoms and molecules	
a- Molecules and atoms move at the same speed within three phases .	12a ,23a
b- The smaller molecules means the greater speed molecules have .	18b
c- The more space to move the greater speed molecules have.	18c
d- Atoms or molecules have no vibrations whenthey are in solid phase .	5d
V- The Composition of Molecules	
a- Compounds don't contain more than one type atoms.	11a , 9a
VI- The Shape of Atoms and Molecules	
a- Temperature may affect the shape of the molecules .	16a
b- Pressure may affect the shape of the molecules.	17b
c- Container will affect the shape of the molecules.	16c
d- An atom resembles a solid sphere when they are in solid phase.	5d
e- Shape of an molecule depends on what phase they are in	19e

To examine content validity and appropriateness, the items were evaluated by chemistry teachers and chemistry education expert. In addition to this, the reliability of the test was found 0.76 after doing the reliability analysis.

Atoms and molecules concepts test was administered before treatment as a pre-test to evaluate students' prior knowledge about atoms and molecules concepts . Then , it was also applied as a post-test to evaluate the effects of treatment on students' understanding of atoms and molecules concepts. (See Appendix B)

4.4.2. Science Process Skills Test (SPST)

This test originally developed by Wise, Okey and Burns (1982) and translated and adjusted into Turkish by Geban, Aşkar, Özkan (1991) containing 36 multiple choice questions. Each question contains four alternatives. It was administered to both experimental and control groups at the beginning of the study. The reliability of the test was found 0.85. Science process skills test measures different objectives. These are identifying variables, graphing and interpreting data, identifying and stating hypothesis, operationally defining, and designing investigation (See Appendix D).

4.4.3 Attitude Scale Toward Chemistry (ASTC)

This scale developed by Geban and Ertepınar which consisted of 15 items in a point likert scale (fully agree, agree, undecided, partially agree, fully disagree) in Turkish (Geban et al., 1994). The present study this scale was administrated as a pre-test and post-test to evaluate students' attitude toward chemistry. Reliability of the scale was found 0.834. (See Appendix E)

4.5.Treatment (CCTOI vs. TDI)

This research was carried out about two weeks during the 2004-2005 fall semesters. There were 45 tenth grade students from two separate classes taught by the same chemistry teacher in the study.

Two different instructional methods were applied to Experimental and Control groups. Experimental group was instructed by conceptual change texts oriented instruction accompanied with analogies, but the control group instructed by the traditionally designed chemistry instruction . In the first stage, AMCT, ASTC

and SPST were administrated as pretests to both groups to determine if these two groups were equivalent in therms of the parameters.

Chemistry class session was 45 minutes in the school . During the treatment , each class was exposed to the same amount teaching time and took the same materials except conceptual change text and analogies for the experimental group. Equal opportunities were given to the students in the experimental group to participitate instructions . Before delivering the conceptual change text, students were asked to draw carbon , hydrogen atoms and carbondioxide, and water molecules' models that best represent the models in their ideas.After delivering the conceptual change texts, a part of the text related to the subject was read and discussed in in the classroom .

On the other hand, In control group, traditionally designed chemistry instruction was used by applying the lecture method by the researcher. Teaching methods was based on explanations, questioning and textbooks. Therefore, the misconceptions were not took into the account and explanations, definitions , concepts were presented on the blackboard. Inaddition to this, quantitative problems which are based on University Entrance Exam were solved by the researcher .

The experimental grup was instructed by the conceptual change text oriented instrcution with the analogies .After first two chemistry class sessions , The conceptual change text was given to the experimental group consisting of 22 students. It was prepared by the researcher by searching for the literature and internet sources. The conceptual change text was developed in a way that adresses the miconceptions about atoms and molecules concepts. It has sort of information that illustrates the inconsistencies between misconceptions about atoms and molecules and scientific knowledge. It also includes examples and figures to activate the misconceptions about atoms and molecules. The scientific knowledge

and explanations of this text has a kind of properties that are plausible and intellegible .

There are four main parts of the conceptual change text .

1.Atoms and their relations with nature of the Earth
   i. How much an atom is small ?
   ii. Visibility of atoms
   iii. Atoms and molecules
2. Elements
3. Atoms and its structure
   i.What does an atom look like ?
   ii. Protons and neutrons
   iii.Electrons and their movements
   iv. Electrons' distribution in an atom
   v.Number of protons , neutrons , and electrons in an atom
   vi . The size and weight of atoms
4. Molecules
   i. The reletion between atoms and molecules
   ii. Movements and energy of molecules in three phases of a substance
   iii. Observable properties of a substance and its molecules
   iv .Molecular weight and three phases of a substance
   v. Size and shape of molecules and three phases of a substance

Conceptual Change Text (see appendix C) in the study identified the misconceptions about atoms and molecules and corrected them by giving analogies, examples, figures and scientific explanations .In this way, in the first case, students were expected to be dissatisfied with existing conceptions, then corrected them by giving analogies, figures, and examples . Analogies, figures and examples were selected and created in a way that they are focused on the target miconception in order to change the misconception to the scientific conception.

During the treatment, the parts of the coceptual change text were given to the students before regular cemistry class- hours so that the students were able to make use of it to correct misconceptions about atoms and molecules .After coming the classroom, a part of the conceptual change text was read and discussed . This text indicated why the some students' ideas and concepts are incorrect and gave the scientific explanations of the phenomena. In cemistry class-hours, this function of the conceptual change text was supported by discussions that dissatify the students' misconceptions and give the plausible and intellegible explanations for the natural phenomena . After reading the text, the new concepts, or scientific concepts and the misconceptions were discussed by the researcher and students in a close interaction.

4.6.Analysis Of Data

ANCOVA was used for comparing the effectiveness of the instructional method and gender on understanding atoms and molecules concepts while the results of the students' science process skills test were used as covariate . However, ANOVA was used to determine the difference of the post-test scores of experimental and control groups with respect to the scores of attitudes toward chemistry as a school subject . ANOVA was also used to determine the effect of gender difference on students' the scores of attitude toward chemistry as a school subject.

4.7 Assumptions and Limitations

4.7.1.Assumptions

1. Students in both groups were sincere and accurate in answering questions in the instruments used in the study.

2. Experimental and control group students did not interact during treatment.

3. Teacher was not biased during study.

4. Besides conceptual change text, other methods that modify the post-test results of the students were not used in the experimental group.

4.7.2. Limitations

1.The study was limited to Atoms and Molecules concepts.

2.The subjects of the study were limited to 45 tenth grade students from Elmadağ Lisesi .

CHAPTER 5

RESULTS AND CONCLUSION

The results of the hypothesis were presented in this chapter . ANCOVA and ANOVA were used for testing the hypothesis of the at a significant level of 0, 05. SSPS (Statistical Package for Social Sciences for personal computers) was used for performing the statistical analysis.

5.1 Results

To determine the students' previous knowledge and concepts and attitude towards chemistry, and their science process skills, AMCT (Atoms and Molecules Concept Test), ASTC (Attitude Toward Chemistry as a school subject), SPST (Science Process Skills Test) were administrated as pretests before treatment .

The results of pretests showed that there was no siginificant difference between CCTOI and TDI groups in terms of Atoms and Molecules Achievement ($t = 1,52$, $p > 0,05$) ; attitudes toward science as a school subject ($t = 0,55$, $p > 0,05$) ; and science process skill ($t = 0,87$, $p > 0,05$) .

Hypothesis 1 :

ANCOVA was used to test the Hypothesis 1 that there is no significant difference between post-test mean scores of the students taught with TDI and those taught with CCTOI with respect to their understanding of atoms and molecules concepts when the students' science process skills are controlled. Hence , the results of this analysis were depicted on table 5.1.

Table 5.1 ANCOVA Summary (Achievement)

Source	df	SS	MS	F	P
Covariate (Science Process Skills)	1	143,428	143,428	13,316	0,001
Treatment	1	213,518	213,518	19,824	0,000
Gender	1	6,251	6,251	0,58	0,451
Gender*Treatment	1	11,171	11,171	1,037	0,315
Error	40	430,836	10,771		

The result of the study showed that there was significant difference between post-test mean scores of the students taught with CCTOI and the students taught with TDI with respect to their understanding of atoms and molecules concepts. (F =19,82 , P = 0,0 < 0,05) In addition , the mean score of CCTOI is significantly higher than that of the TDI group . ($\overline{X}$(CCTOI) = 13.13 ; $\overline{X}$ (TDI) = 8.36) . Figure 5.1. depicted the correct responses of atoms and molecules concept test of these two groups .

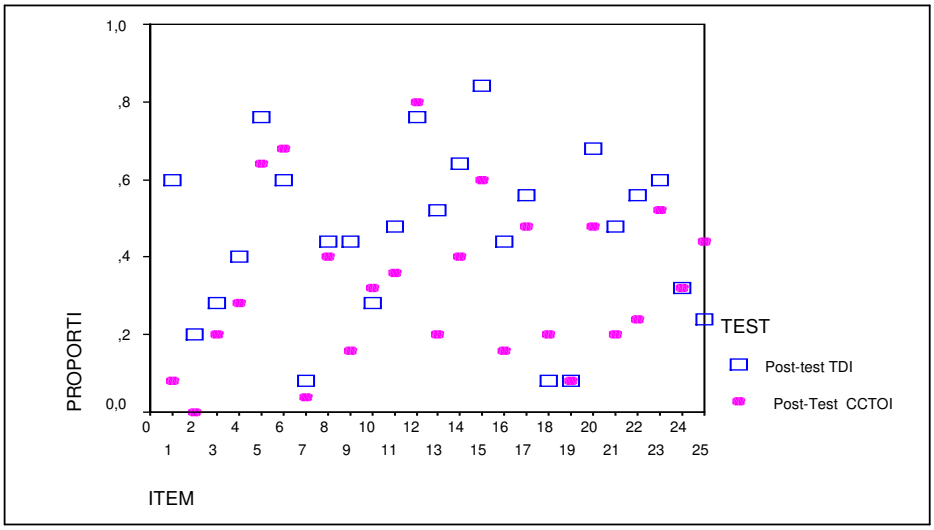


Figure 5.1. Comparison between post-test scores of CCTOI and TDI

Figure 5.1. showed that there is a significant difference between group TDI and group CCTOI students' responses .Specifically , there is a big difference for the questions 1 ,6,9, 12, 15, and, 21 . For instance ; 60 % of the CCTOI group students replied correctly question 1, while only 16 % of the TDI group students replied it correctly . This question asked students about visibilty of an atom, and it tried to grasp the misconception that an atom can be seen if optical, or other types of microscopes are used .That result showed that most of the students inTDI group confused the visibility of a atom . In question 6 , it was tried to investigate the misconceptions that all atoms have the same size and electrons are heavy enough to be contributed the weight of an atom. 60 % of students in CCTOI group replied this question correctly, while 28 % of those in TDI group replied it correctly . Similar result can be observed in the question 9, bacause students of group CCTOI replied this question correctly at 44 % rate, while TDI students gave the correct answer to this question at 20 % rate .All these results from the questions 1, 6 , 9, and 21 have showed that students in TDI group have misconceptions about atomic size at higher proportions than the students in CCTOI. In question 12, students were asked to search the their own ideas about energy and speed of molecules . 76 % of students in CCTOI replied it correctly , but nearly half of the students (48 %) in TDI group respoded that question correctly. Questions 2 and 24 asked about the movements of the electrons in an atom and both groups responded them at lower proportions . In spite of this fact, CCTOI group replied both of them at higher proportions (% 20 and % 32 respectively) than TDI group (% 0 and % 12 respectively). It can also be investigated the same treatment effect on the questions with higher achievement levels because , students in CCTOI group still were able to reply the questions at higher proportions . The questions 4, 15 tried to look for the student's misconceptions about weight of molecules and atoms . The question 15 tried to look for the misconception about molecular weight and phases of the substances . CCTOI group gave the correct responses at 84 % rate whereas TDI group replied it at 56 % rate. CCTOI group showed higher achievement (40 %) than the other group (20 %) for the question 4 . Both

groups replied correctly at almost equal proportion for the question 19 and 20. After the treament , the average correct response for CCTOI group was % 46 and for TDI group was 29. Therefore , we can conclude that students in CCTOI group understood atoms and molecules concepts better than the TDI group students.

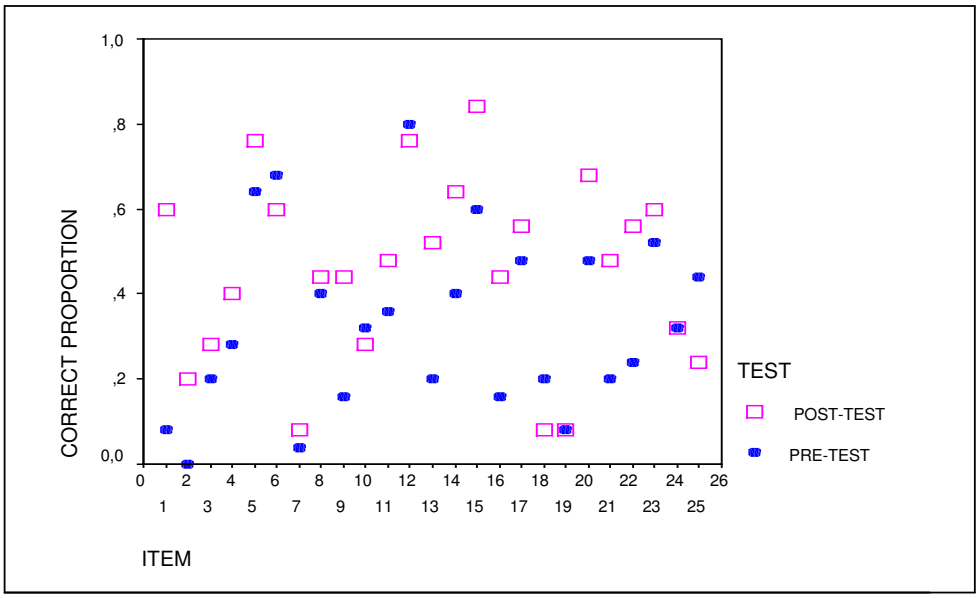


Figure 5.2. Comparison between pre-test and post-test scores of students in CCTOI group.

Figure 5.2 depicted the comparison of the percent rate of the correct responses of the AMCT for the CCTOI group students . The average correct response percent was % 33 for the pretest administrated efore treatment and it increased 45 % after the treatent . Specifically , students made a great improvement for the questions 1,9, 13 , 14 ,15 ,16 ,20 ,21 ,22 . For instance ; 92 of the students held the conception about the visibility of an atom before treatment , and 40 % of them held this misconception afer treatment.

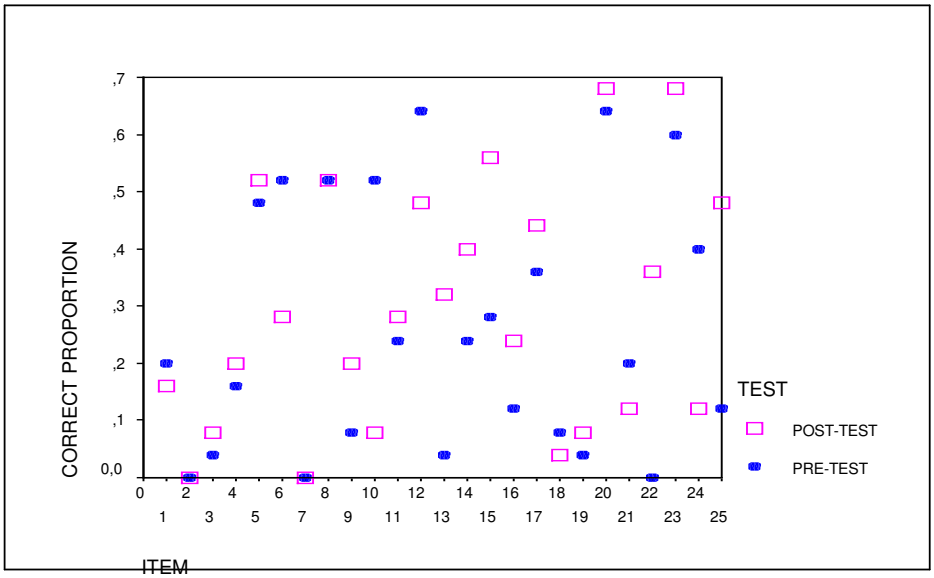


Figure 5.3. Comparison between pre-test and post-test scores of students in TDI group.

Figure 5.3 depicted the TDI group's correct response rate for the pretest and post test . An improvement can be investigated because average correct response percent was 25 before the treatment , and it raised to 29 % after the treatment . But this increasing is not as much as in CCTOI group students . In questions 13,15, 22, 25 students in TDI made great improvement but treatment had a negative effect on them for the questions 10 , 12 , 21 , and 24 . For instance question 21 , 88 % of the students in TDI group still held the misconception about the movemets of electrons . The treatment had slightly positive effect for the qeuestions 3, 4 ,5 , 9,11,14, 19, and 23 . For instance ; in question 14 , 40 % of the students in TDI group didn't hold the misconception about molecular size and phases of the substances .

After all of these result . it can said that students in CCTOI group understood atoms and molecules concepts better than the students in TDI group.

Hypothesis 2:

ANCOVA was used to test the hypothesis that there is no significant difference between post-test mean scores of girls and boys with respect to their understanding of atoms and molecules when the students' science process skills are controlled. The result of the analysis showed that there was no significant difference between the performance of boys and girls with respect to their understanding of atoms and molecules concepts ($F = 0,58$, $p = 0,451$). According to this result , there was no any difference between girls and boys in terms of atoms and molecules concepts .

Hypothesis 3:

Another hypothesis that was tested with ANCOVA is that there is no significant effect of interaction between gender and treatment on students' understanding of atoms and molecules concepts when the effect of students' science process skills is controlled. The result of the analysis showed that the effect of interaction between gender and treatment didn't contrirubute significantly to stuents' understaning of atoms and molecules concepts . ($F= 1,04$, $p= 0,32 > 0,05$).

Hyphothesis 4:

Analysis of covariance was used again to test the question in the this hypothsis that there is no significant contribution of students' science process skills to the variation on their understanding of atoms and molecules concepts. The result of this analysis showed that science process skills made a significant contribution to the variation on students' understanding of atoms and molecules concepts ($F = 13,32$, $p = 0,001 <0,05$).

Hyphothesis 5:

ANOVA was used the hypothesis that there is no significant difference between post-test mean scores of the students taught with TDI and those taught with CCTOI with respect to attitudes toward chemistry as a school subject.The result of this analysis was given on the table 5.2

Table 5.2. ANOVA Summary (Attitude)

Source	df	SS	MS	F	P
Gender	1	131,588	131,588	2,201	0,146
Treatment	1	352,253	352,253	5,893	0,02
Gender*Treatment	1	200,647	200,647	3,357	0,074
Error	41	2450,654	59,772		

The result of analysis showed that there was a significant difference between post-test mean scores of the students taught with TDI and those taught with CCTOI with respect to attitudes toward chemistry as a school subject.(F=5,89 p=0,02). It can be understand this result from the mean scores of the post attitude scores .($\overline{X}$ (CCTOI) = 58.17 , $\overline{X}$ (TDI) = 54.32).

Hyphothesis 6:

This hypothesis that there is no significant difference between boys and girls with respect to their attitudes toward chemistry as a school subject was tested the ANOVA . The result of the analysis showed that there was no significant difference between boys and girls with respect to their attitudes toward chemistry as a school subject. (F = 2.20 , p= 0.146 >0,05)

Hypothesis 7:

ANOVA was used again to test this hypothesis that there is no significant effect of interaction between treatment and gender difference on students' attitudes toward chemistry as a school subject. In this case , the result of the analysis showed that

there was no significant effect of interaction between the treatment and gender difference on student's attitudes towards chemistry as a school subject .(F= 3.36 , p = 0.74 >0,05).

The other results can be found in the drawings of the students. In activity 4, students in CCTOI group were asked to draw Carbon , Helium atoms and Water and carbondioxide molecules .Examples of the drawings were showed on figures 6.1, 6.2, 6.3, 6.4 and 6.5.

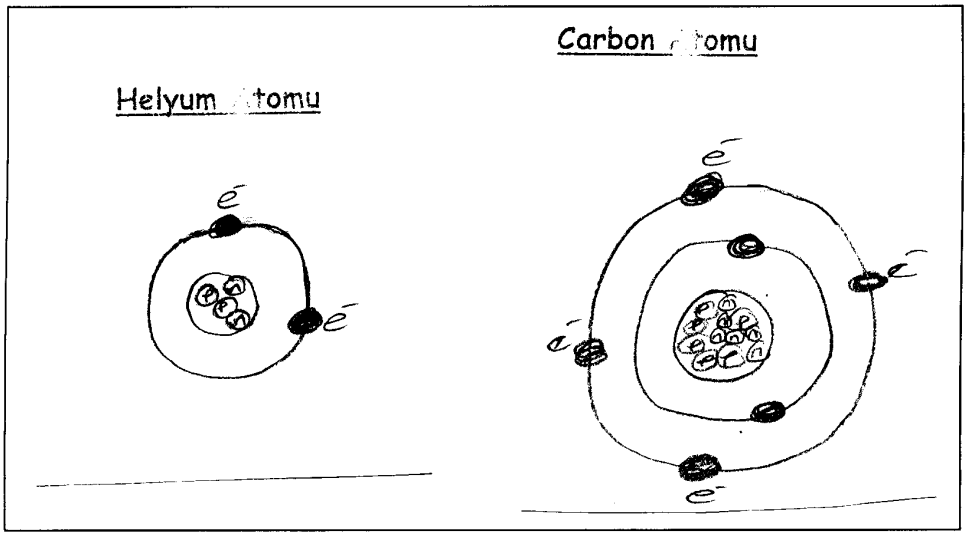


Figure 5.4 . Drawings of Carbon and Helyum atoms .

The drawings of some students on figure 6.1 used the model called as solar system model.(Harrison and Treagust ,1996). Students could identify the particles of atom separately but drew the electron paths as a complete circles .They weren't able to show the relative size of the nucleus and the size of atom. The relative distance between electrons and nucleus was not depicted correctly .

Figure 6.2 depicts the drawing of a water molecule . The student could identify the composition of the molecule and the particles of each atom, But they couldn't identify the sharing the electrons between the atoms correctly.The size of the nucleus and the size of the atoms were nto drawn correctly.

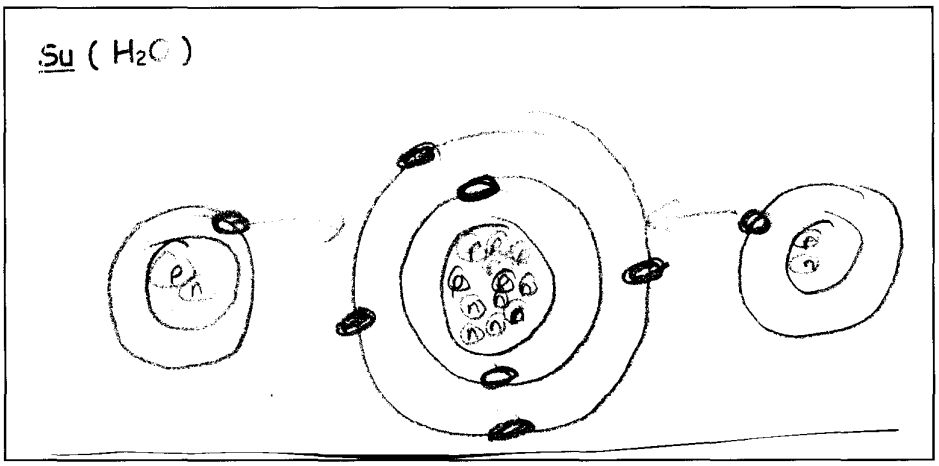


Figure 5.5. Drawing of water molecule

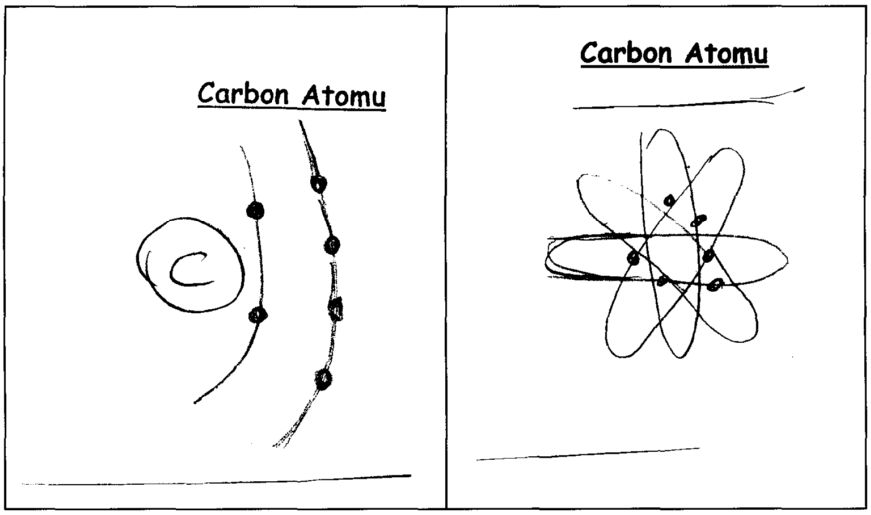


Figure 5.6. Drawings of Carbon atoms by two different students

Figure 6.3 depicts two different drawings of Carbon atom from two different students . The first drawing (left hand side) could show the electrons , enegy levels and nucleus of the atom but not protons and neutrons of the atoms. The other

probable electrons' regions were not showed in any way. The other drawing was drawn in a way that consists with the model called as orbits model (Harrison and

Treagust ,1996). In spite of showing electrons and their number , student was not able to show nucleus and its components and energy levels of the electrons .

Figure 6.4 and 6.5 depicted carbon and carbon dioxide drawing by a student . He gave a misconception that an atom looks like a cell. Two of the students participated the study gave that misconception . See figure 6.4 and 6.5.

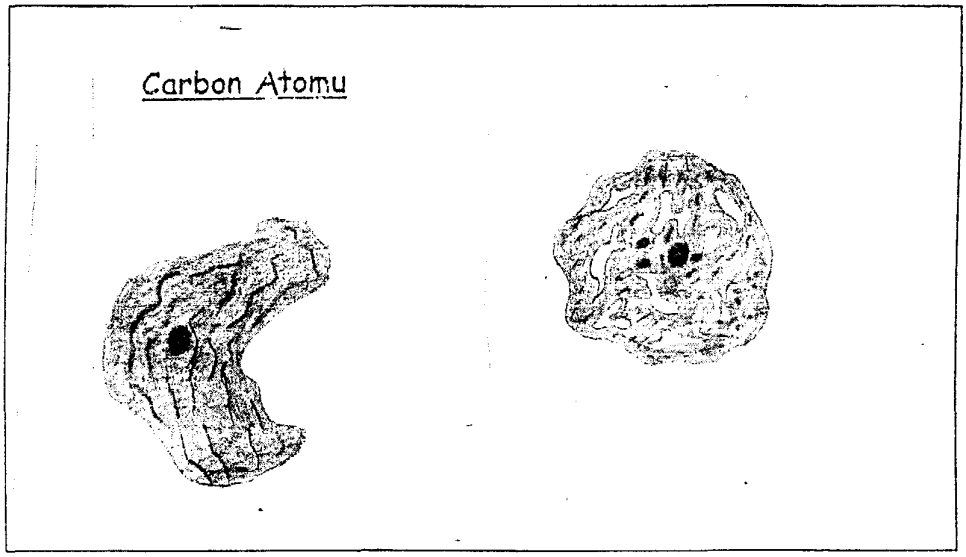


Figure 5.7. Carbon and Helyum atoms' drawings by the same student.

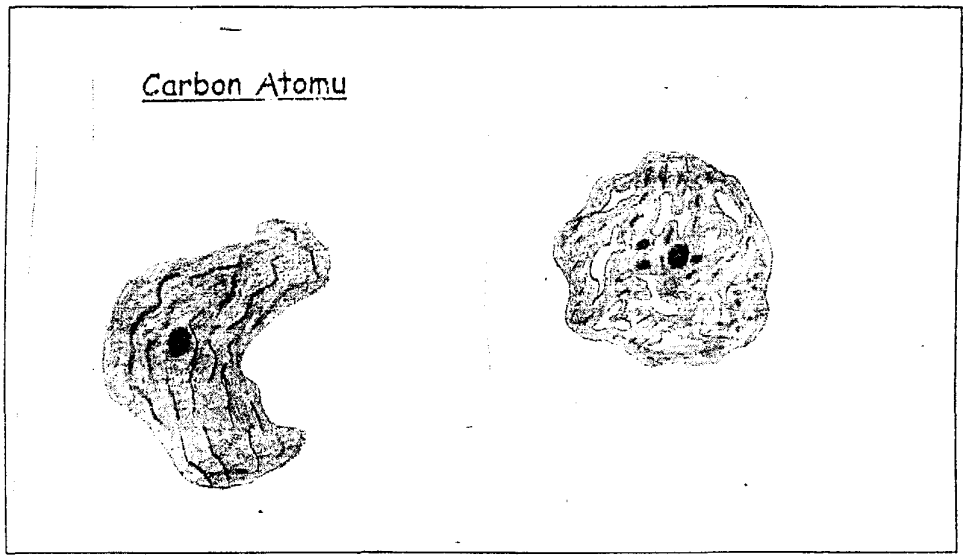


Figure 5.8. Carbondioxide drawing by a student.

5.2. Conclusions

According to these results , the following conclusions can be stated :

1) The CCTOI gave a significant scientific acquisition in understanding atoms and molecules related concepts .

2) The CCTOI was able to give more scientific knowledge and skills to reduce the misconceptions related to atoms and molecules than TDI .

3) There was a improvement in both CCTOI and TDI groups, but the CCTOI gave a higher improvement in understanding of atoms and molecules concepts .

4) Students' science process skills were a strong predictor for the understanding of atoms and molecules concepts.

5) It wasn't observed any significant effect of interaction between gender and treatment in students' understanding atoms and molecules related concepts.

6) Boys and Girls were equivalent in understanding atoms and molecules related concepts for the both of the treatment groups .

7) The CCTOI gave more positive attitude towards chemistry as a school subject than TDI .

8) Boys and girls in both groups were equal after the treatment with respect to their attitude toward chemistry as a school subject.

9) There was no significant effect of interaction between treatment and gender difference on students' attitudes toward chemistry as a school subject.

CHAPTER 6

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

In this chapter, the results presented in the previous chapter will be disscussed and also implications and recommedations will be presented for the further researches .

6.1 Discussion

The main purpose of this study was to compare the effectiveness of Conceptual Change Text Oriented Instruction accompanied with analogies (CCTOI) and Traditionally Designed Chemistry (TDI) Instruction on 10^{th} grade students' undertanding of atoms and molecules concepts. In additon to this, the misonceptions which are related to atoms and molecules concepts were searched and investigated .

In the first stage of the research, atoms and molecules concept test was administrated as a pretest. Administrating this test first time indicated that there was no significant differences between the the scores of the both groups engaged the research. After applying the treatment , the same test was administrated both groups as a post test and, the CCTOI group students gained higher scores than the students in TDI group .According to the these results, it became possible to conclude that conceptual change text instruction with analogies was more effective significantly to grasp the scientific knowledge, to understand conceptually the natural phenomena than traditionally designed instruction. At the same time, this result supprted the idea that traditional designed instruction is not enough to eliminate the misconceptions . In present study, a significant difference in AMCT post scores was investigated for the CCTOI group and TDI group whose avarage

correct resposes for AMCT are % 53 and % 33 respectively . These results are supported findings by Çakır, Uzuntiryaki, Geban (2002); Yürük and Geban, (2001); Andre Chamber,(1997); and Uzuntiryaki (1998) that conceptual change text instruction was more effective to get better understanding of scientific conceptions . Higher scores of the students in CCTOI group may come from several reasons .Conceptual change text was the main component of conceptual text oriented instruction and considered the students' intuitive ideas and misconceptions . It helped students consider the pre-existing ideas and created a conflict between the students' misconceptions ,their intuitive ideas and scientific knowledge by demostrating inconsistencies between them. This conflict caused students to be dissatisfied with intuitive ideas and misconceptions and , this dissatisfaction enabled conceptual change text to restructure the compatible knowledge of students in CCTOI group and realize their misconceptions .In addition, the dissatisfaction also opened the way for the conceptual change text to explain why some of the students' ideas are not true and why scientific ones are true by giving examples and evidences within its content . Beside elimination of misconceptions , conceptual change text caused enhace the organization of conceptual frame work to grasp the new concepts and knowledge . Hence, the process capacity increased and that also raised the ability of correcting the misconceptions .This effect of conceptual change text is supported by Boujaoude(1992). As a result, conceptual change text caused students in CCTOI group to raise their scores on post –test scores of AMCT and to gain more conceptual understanding.

In addition this , students were participated to the chemistry -class hours by appllying some discussions so that students became activated in the classroom . Espacially, after the reading conceptual change text , students were encouraged to discuss and share their previous ideas so that their intuitive ideas and misconceptions about atoms and molecules were activated .During this process , there was a close interaction between the instructor and the students .Instructor guided the discussions that could facilitate the meaningful and conceptual learning. Discussion enviroment created by the students in the class provided a special

learning environment and enabled students to share and criticize their ideas. This situation also caused dissatisfaction and restructuring the previous knowledge and acquisition the scientific knowledge . In this discussion environment , students were able to acquire feedback for the accuracy of their ideasand knowledge.This condition was also supported by the findings of Alvermann et . al .(1995) who concluded that more pronounced effect can be obtained if the text type on learning counterintuitive science concepts was combined with a supportive activity such as a small group discussion **.** In addition, Uzuntiryaki (1998); Yürük and Geban (2001) emphasized the positive role of the discussion in the conceptual change text instruction.

At the beginning of the instruction , students in the in CCTOI group were asked to draw an image of carbon and helyum atoms and water and carbondioxide molecues . Different findings were obtained in the this stage. Students indicated different misconceptions which are related to the atoms and molecules . One them is that an atom looks like a cell . This finding is supported by Harrison and Tregust (1996), Griffiths and Preston (1992), Osborne and Freyberg (1985). In figure 6.1 and 6.2 , students used the similar models that can identify the basic particles of the atoms and energy levels of electrons , but not relative size of the nucleus and atomic radius, and distance between the nucleus and electrons . Some of the students gave an impression being affected by the text books .(See figure 6.3). Specifically, the drawing used in the left part of the Figure 6.3 looks like the models used text books for the high school entrance exams . Most of the students didn't realize their models have some shared attributes and unshared attributes .Bucause of this fact , students cannot realize that unshared attributes caused them to have misconceptions related atoms and molecules .

However, In traditionally designed instruction, the chemistry class sessisions were based on the teacher explanations of scientific phenomena ,logical presentation of knowledge, some examples given in the textbooks and texts , solving the quantitative problems. Students' previous ideas ,misconceptions related to the atoms and molecules were not took into the account in this instruction .

Discussions of the concepts and the conceptual knowledge given in the instruction were limited so that students' engagement to chemistry class sessions in TDI were confined to the solving the quantitative problems and understanding of explanations of scientific phenomena . TDI didn't didn't provide a progress for the conceptual frameworks of the students in TDI group. As a result , this situation may became a reaoson why students in CCTOI group got the better scores than the students in the TDI . Students had less ability to grasp the concepts and they got lower scores from post-test of the AMCT which is composed conceptual questions . Traditional instruction didn't give enough progress in understanding the concepts related to atoms and molecules .

Attitude scale toward chemistry as a school subject was administrated to the students at the beginning of the treatment, no significance difference was investigated between the CCTOI group and TDI group with respect to attitude scale toward chemistry as a school subject (ASTC). After the treatment , ASTC was administrated to both CCTOI and TDI groups again, a significant difference was investigated between CCTOI and TDI groups. According to the results obtained in post- ASTC scores , group CCTOI scores were higher than those of group TDI . This means that group CCTOI showed more positive attitude toward the chemistry than group TDI after the treatment. Several reasons may be accounted for that result . First , increasing the conceptual understanding atoms and molecules after the treatment may give more skills to solve problems and understand chemical phenomena and that progress made attitudes of the students in CCTOI toward chemistry changed positively. Second , discussions between the students and researcher may raise the interesting of students toward chemistry in CCTOI group . Because, these discussions made them participitate actively to the chemistry class sessions and they were able to live the experience to see that why their ideas are true or not . That also may support the belief of being succesful in chemical phenomena. Analogies may be helpful to all these factors on students in CCTOI group . However, these factors didn't affect the students in TDI group and traditional chemistry instruction didn't affect the students in this group so that a

positive improvement in attitudes of students toward chemistry wasn't investigated in the post-test of ASTC.

Science process skills test was admistrated both TDI and CCTOI group students in order to investigate the effect of science process skillls of students on understanding atoms and molecules concepts . The result of the analysis showed that the science process skills contributes significantly to the variation on students' understanding of atoms and molecules concepts . As it was understood from this result , the science process skills is an effective predictor, because solving complex chemistry problems, espacially for qualitative chemistry problems, conceptual understanding of chemistry subjects require abilities to identify variables, state hypothesis, define operations , investigation of scientific phenomena, interpretation of data and graph etc. Thus, science process skills have a significant effect on the meaningful learning and conceptual understanding of cemistry subjects .

One of the results of the analysis was the gender effect on understanding of atoms and that molecules concepts . The result of the analysis showed that there was no sigificant difference between the girls and boys in both of two groups in understanding atoms and molecules concepts . During the treatment , girls and boys were exposed the same meterials , teaching methods in both TDI and CCTOI group classes . In other words, they were under the same conditions . That factor may be the reason of this analysis' result .

The present study tried to search and determine the misconceptions about atoms and molecules concepts in chemistry . In so doing , conceptual change text was the main instructional tools of the study .The some of the misconceptions that presented in this study may not be investigated as often as some of them, but all of them have the probability to be encountered for science teachers in the classroom .

In summary , the Present study showed that the conceptual change text oriented instruction accompanied with analogies provided better conceptual

understanding of atoms and molecules and gave more opportunities to eliminate the misconceptions about the atoms and molecules concepts than the traditional instruction in chemistry . This research also indicated conceptual change text oriented instruction has a significant importance as a teaching strategy to address the misconceptions in chemistry concepts .

6.2 Implications

The implications of the present study can be stated as follow :

1. Students may have some misconceptions about atoms and molecules and chemistry teachers should take them into the considerations during the cemistry instruction.

2. Misconceptions and students' intutive ideas may prevent the conceptual understanding of the chemistry . During the instructions science teachers must have the ability to recognize such a case .

3.Conceptual change text provides a better conceptual understanding of chemial phenomena .

4.Traditional instruction is not enough to understand conceptually chemical phenomena .

5. Science teachers sould be informed and encouraged to use coneptual change texts in instructional activities .

6. Conceptual change texts have the ability to revise the student's knowledge about the natural phenomena and reconsruct the conceptual framework of the students .

7. If a conceptual change text is used in insructional activities ,teacher must enable students to discuss the conceptual knowledge about the natural penomena in the classroom .

8. Teachers must pay attention the concepts , examples,figures and language that used in the material such as textbooks , texts .

9. Science process skill is a strong predictor to uderstand the chemistry . Teachers should consider how to improve the science process skill when they design instructional activities .

10 . Teachers must develop such teaching strageties that students think about their intuitive ideas , misconceptions and that they can easily eliminate these misconceptions .

6.3. Recommendations

1. For the future researches , different chemistry subjects may be selected to investigate the effcects conceptual change text instruction .

2. For the future researches , the effect of conceptual change text oriented instruction may be compared with other other instructional techniques such as cooparative learning , computer asisted instruction .

3. For the future researches , an interview may be combined to the present study invetigate the effects of conceptual change text oriented instruction.

4. Similar studies can be conducted for the different grade levels and different courses .

REFERENCES

Alvermann , D. E., Smith, L. C . , & Readence, J. E. (1985). Prior Knowledge a-Activation and the Comprehension of Compatible and Incompatible Text. *Reading Research Quarterly*, 20, 420-436.

Anderson, C. W., & Roth, K. J. (1988). Teaching for Meaningful and Self-Regulated Learning of Science. In J. Brophe (Ed.), *Teaching for Meaningful and Self-regulated learning.* Greenwich, CT: JAI Press.

Anderson , C.W. , & Smith ,E.L. (1983) .How Swedish pupils , Aged 12-15 Years ,Understand Light and Its Properties. *European Journal of Science Education,* 5(4) , 387-402 .

Andersson, B. (1990). Pupil's Conceptiond of Matter and its Transformation (age 12-16)*Studies in Scien Education* ,18 , 53-85.

Anderson, C.W., & Smith, E.L. (1987).Teaching Science. In V.Richardson-Koehler Ed., *Educator's handbook*: A research perspective. New York: Longman.

Basili , P.A. , Sanford , J.P.(1991).Conceptual Change Strategeis and Cooperative Group Work in Chemistry .*Journal of Research in Science Teaching*, 28 (4),293-304.

Belkin, G. S. and Gray, J. L. (1977). *Educational Psychology: An Introduction.* Dubuque Iowa: Wm. C. Brown Company Publishers.

Ben-Zvi , R. , Eylon, B., & Silberstein , J. (1986). Is an Atom of Copper Malleable ? *Journal of Chemical Education* ,63 (1),64-66.

BonJaoude, S. (1992). The Relationships Between Students' Learning Strategies and the Change in Misunderstandings During a High School Chemistry Course. *Journal of Research in Science Teaching*, 29(7), 687-699.

Brook ,A. , Briggs , M., & Driver , R . (1984) Aspects of Secondary Students' Understanding of the Particulate Nature of Matter .Leeds : *University of Leed s Children's Learning in Science Project. Centre for in Science and Mathematics Education* .

Buojade , S.B. (1991). A Study of the Nature of Students' Understanding About the Concept of Burning . *Journal of Research in Science Teaching* , 28 , 689-704 .

Çakır , Ö.S. , Uzuntiryaki , E. , Geban , O .(2002) Contribution of Conceptual Change Texts and Concept Mapping to Understanding of Acids and Bases . *A paper presented at Annual meeting of the National Association for Research in Science Teaching , New Orleans , LA.*

Caramazza ,A. ,McCloskey, M. ,& Green , B. (1981). Naïve Beliefs in 'Sophisticated ' Subjects : Misconceptions About Trajectories of Objects .*Cognition* , 9, 117-123.

Carey , S. (1985) Conceptual Change in Childhood .*Cambridge ,* MA: Harvard University Press .

Chambers , S.K. , & Andre , T. (1997). Gender, Prior Knowledge , Interest and Experience in Electricity and Conceptual Change Texts Manipulations in Lerning About Direct Current . *Journal of Research in Science Teaching ,* 34 , 107-123.

Cho ,H. , Kahle , J.B. & Nordland F.H. (1985). An Investigation of High School Biology Textbooks as Sources of Misconceptions and Difficulties in Genetics and Some Suggestions for teaching Genetics . *Science Education ,* 69 (5) 707-719.

Clement , C.A.(2002). Learning With Analogies, Cases, and Computers.*The Journal of the Learning Sciences* , 11(1), 127–138.

Coll, R.K. and Treagust , D.F. (2002).Learners' Use of Analogy and Alternative Conceptions for Chemical Bonding : A Cross- Age Study . *Australian Science*

Teachers' Journal .48(1) , 24-32 .

Dagher, Z. R. (1994). Does the Use of Analogies Contribute to Conceptual Change. *Science Education*, *78*, 601-614.

Driver, R., & Easley, J. (1978).Pupils and Paradigms: A review of Literature Related to Concept Development in Adolescent Science Students. *Studies in Science Education,* 5, 61-84.

Driver, R. ,& Erickson , G. (1983). Theories in Action : Some Theoretical and Emprical Issues in the Study of Students' Conceptual Frameworks in Science .*Studies in Education ,* 10,37-60.

Duit,R.(1996). *Lernen als Konzeptwechsel im naturwissenschaflichen Unterricht*. In R.Duit & C. von Rhöneck(Eds), Lernen in den Naturwissenschaften.Beitrage zu einem Workshop an der Padagogischen Hochschule Ludwigsburg, Kiel, Germany,145-162.

Duit ,R . , & Treagust , D.F.(1995). Students' Conceptions and Constructivist Teaching Approaches . In Fraser , B.J. & Walberg (Eds .) , Improving Science Education. Chicago, *The National Society for the Study of Education.*

Duit,R.(1991).On the Role of Analogies and Metaphors in Learning Science. *Science Education,* 75,649-672.

Dysktra, D.I.JR., Boyle, C.F.,& Monarch, I.A.(1992). Studying Conceptual Change in Learning Physics. *Science Education*, 76(6), 615-652.

Dykstra, D. (1992). Studying conceptual change. In R. Duit, F. Goldberg, & H. Niedderer,Eds.,Research in Physics Learning: Theoretical Issues and Empirical Studies.(pp. 40-58). Kiel, *Germany: Institute for Science Education at the*

University of Kiel.

Else, J.M and Clement J. (2003). Should Different Types of Analogies Be Treated Differently in Instruction ? Observations from a Middle-School Life Science Curriculum. *Proceedings of the National Association for Research in Science Teaching.*

Fellows , N. J. (1994) . A window into Thinking : Using Student Writing to Understand Conceptual Change in Science Learning . *Journal of Research in Science Teaching*, 31 (9) , 611-628.

Fensham, P.F., Gunstone, R.F., & White, R.T., Eds. (1994). The Content of Science: A constructivist Approach to Its Teaching and Learning. London, UK: Falmer Press.

Furletti , C. , and Rule, A.C. (2004) . Using Form and Function Analogy Object Boxes to Teach Human Body Systems .*School Science and Mathematics,* 104(4) , 155-169.

Gabel, D. L., & Samuel,K.V.(1986).High School Students' Ability to Solve Molarity Problems and Their Anolog Counterparts. *Journal of Research in Science Teaching,* 23,165-176.

Gabet , D. ; Samuel , K.V. ; Hunn, D.J. (1987). *Jornal of Chemical Education,* 64, 695-697

Gentner, D. 1999. Analogy. IN: *MIT Encyclopedia of the Cognitive Sciences* Massachusetts Institute of Technology. cognet.mit.edu/MITECS/

Gilbert , J.K. , & Osborne , R . J ., & Fensham , P.J. (1982). Children's Science and Its Consequences for Teaching . *Science Education* ,66 , 623-633.

Gilbert , J.K. , & Zyberstajn , A. (1985). A Conceptual Framework for Science Education : the Case Study of Force and Movement . *European Jornal Of Science Education ,* 7, 107-120.

Glynn, S.M. (1991). Explaining Science Concepts: A Teaching With Analogies Model. In S. Glynn,R, Yeany & B, Britton (Eds.), *The Psychology of Learning Science* (pp. 219-240). Hillsdale, NJ:Lawrence Erlbaum.

Goldblum, N. (2001). The Brain Shaped Mind. New York:*Cambridge University Press.*

Griffiths , A.K. and Preston , K.R. (1992). Grade 12 Students' Misconceptions Relating to Fundamental Characteristics of Atoms and Molecules . *Journal of Research in Science Teaching*, 29 (6) , 611-628.

Guzzetti, B. J., Snyder, T. E., Glass, G. V., and Gamas, W. S. (1993). Promoting Conceptual Change in Science: A Comparative Meta-Analysis of Instructional Interventions From Reading Education and Science Education. *Reading Research Quarterly*, 28(2), 117-159.

Harrison , A.G. & Treagust D.F. (1996) . Secondary Students' Mental Models of Atoms and Molecules : Implications for Teaching Chemistry . *Science Education* .80 (5) 509-534.

Harrison,A.G. (1992).*Evaluation of a model for teaching analogies in secondary science.* Unpublished master's thesis, Curtin University of Technology, Perth,Western Australia.

Harrison ,A.G .(1994). Is There a Scientfic Explanation for Refraction of Light ? – A Review of Textbook Analogies . *Australian Science Teachers Journal ,(2)*40, 30-35.

Harrison, A.G. ,and Treagust , D.F. (1994). Analogies Avoid Misconceptions with This Systematic Approach. *The Science Teacher , pp.* 41-43

Harrison, A.G. (2002). *A paper Presented at the Annual Meeting of the Australian Association for Research in Education*,

Hein, George E. (1991, October). Constructivist Hearning Theory: the Museum and the Needs of People. *Paper Presented at the CECA Conference* ,Jerusalem, Israel.

Hewson PW, and Hewson MG. (1992). The Status of Students' Conceptions. In: R Duit, F Goldberg, and H Niedderer (Eds), *Research in Physics Learning*: Theoretical Issues and Empirical Studies**.** Institut fur die Pedagogik der Naturwissenschaften an die Universitat Kiel.

Hynd, C.R., McWorter, J.Y.,Phares, V.L., & Suttles,C.W.(1994). The Role of Instructional Variables in Conceptual Change in High School Physics Topics. *Journal of Research in Science Teaching,* 31(9), 933-946.

Kim, S., & Van Dusen, L. M. (1998). The Role of Prior Knowledge and Elaboration in Text Comprehension and Memory: A Comparison of Self-Generated and Text Provided Elaboration. *American Journal of Psychology*, 111, 353-378.

Krawczyk, D.C.; Holyoak , K.J. , and Hummel. J.E (2004). Structural Constraints and Object Similarity in Analogical Mapping and Inference. *Thinking 0 & Reasoning , 10 (1), 85–104*

Lee ,O. , Eichinger , D.C , Anderson , C.W. , and Berkheimer , G.D. , Blakeslee , T.D . (1993). Changing Middle School Students' Conceptions of Matter and Molecules . *Journal of Research in Science Teaching*, 30 (3) , 249-270.

McCloskey , M. (1983). Intuitive Physics.*Scientific American ,* 248, 122-130.

Nakhleh , M.B. (1992) Why Some Students don't Learn Chemistry . *Journal Of Chemical Education* . 69(3) 191-196.

Niedderer, H., Goldberg, F.M. (1993, April). Qualitative Interpretation of a Learning Process in Electric Circuits. *Paper Presented at the Annual Meeting of the National Association of Research in Science Teaching*, Atlanta.

Nieswandt ,M .(2001) . Problems and Possibilities for Learning in an Introductory Cmemistry Course from a Conceptual Change Perspective . *Science Education.* 85 , 158-171.

Novick, S., & J. Nussbaum. (1982). Brainstorming in the Classroom to Invent a Model: a Case Study. *School Science Review*, 62, 771-778.

Osborne ,R ., & Freyberg , P. (1985). Learning in Science : The Implications of Children's Science . *Auckland :* Heineman.

Osborne, R.J.,(1983). Towards Modifying Children's Ideas About Electric Current. *Research in Science and Technological Education*,1,73-82.

Osborne , R.J., Bell , B.F. , & Gilbert ,Y.K. (1983). Science Teaching and Children's View of the World . *European Journal of Science Education,* 5 , 1-14 .

Palmer, D. C. (2002, in press). Cognition. In K. A. Lattal & P. N. Chase (Eds.), *Behavior Theory and Philosophy*. New York: Kluwer Academic Press.

Palmer , D.H. (2003) . Investigating the Relationship Between Refutational Text and Conceptual Change Text . *Science Education* . 87(5) , 663-680.

Perlmutter, J.C., & Bloom, L., & Burrell, L. (1993). Whole Math Through

Investigations. Childhood Education: *Fall ,* 20-24.

Pettus , A.M., & Haley , D. (1980). Identifying Factors Related to Science Process Skill Performence Levels . *School Science and Mathematics* , 80 ,273-276

Posner, G., Strike, K., Hewson, P., &Gertzog, W., (1982). Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change. *Science Education*, 66(2),211-227

Piaget, J.(1950). *The Psychology of Intelligence*. New York: Harcout, Brace.

Rowell, J.A. & Dawson, C.J. (1985). Equilibrium, Conflict and Instruction: A new Class-Oriented Perspective. *European Journal of Science Education*, 5, 203-215

Salisbury-Glennon, J. D., Stevens, R. J., & Du!y, J., (1999, in progress). Conceptions in an Introductory Educational Psychology Course.

Sandomir., M.R. , Stahl , R.J. , & Verdi , M.P. (1993) . The Atom Is/ Is Not a ‘‘Solar System ’’ or an ‘‘Electron cloud ’’: Metaphors as Aids to and Interfers of Acquaring Appropriate Science Content and Conceptions – An Information Constructivist Perspective and Preliminary Findings . *Paper Presented at 66th Annual Meeting of the National Association for Research in Science Teaching ,* Atlanta , GA .

Spigner-Littles, D. and Anderson, C.E. (1999). Constructivism: a Paradigm for Older Learners. *Educational Gerontology,* 25, 203-209.

Stavy , R. (1988) . Children’s Conception of a Gas . *International Journal of Science Education.*

Stavy , R. ,& Stachel , D. (1985) Children's Conception of Changes in the State of Matter : From Solis to Liquid . Archieves De Psychologie ,53 , 331-344.

Strauss ,S. (1981). Cognitive Development in School and Out .*Cognition* ,10, 295-300 .

Sungur, S., Tekkaya, C., & Geban, O. (2001). The Contribution of Conceptual Change Texts Acompanied by Concept Mapping to Students' Understanding of the Human Circulatory System. *School Science & Mathematics,*101(2), 91-102.

Taylor, J. A. (2001). Using a Practical Context to Encourage Conceptual Change : An Instructional Sequence in Bicycle Science. *School Science & Mathematics*, 101(3), 117-125

Taylor, P. (1993). Collaborating to Reconstruct teaching:The influence ofResearcher Beliefs. In K. Tobin, Ed*., The practice of constructivism in science education*. (pp. 267-297). Washington, DC: AAAS Press.

Tao , P.K , Gunstone , R.F. (1999). The Process of Conceptual Change in Force and Motion During Computer – Supported Physics Instruction. *Journal of Research in Science Teaching*, 36 (7) , 859-882.

Thagard, P. (1989). Scientific cognition: Hot or cold. In S. Fuller, M. de Mey and T. Shinn (Eds.) *The cognitive turn: Sociological and Psychological Perspectives on Science* (pp. 71-82), Dordrecht: Kluwer Academic Publishers.

Treagust , D.F. and Venville, G. 1995. Consistency Between the Roles of Analogies in Biology Teaching and Different Perspectives of Conceptual Change. *Paper Presented at the Annual Meetings of the American Ediucational Research Association,* San Francisco.

Uzuntiryaki , E. (1998). Effect of Conceptual Change Approach with Concept Mapping on Understanding Solution Chemistry . *Unpublished Master Thesis ,* The Middle East Technical University , Ankara .

Viennot , L. (1979). Spontenous Reasoning in Elemantary Dynamics . *European Journal Of Science Education* . 1 ,205-221

Yanowitz , K.L. (2001). Using Analogies to Improve Elementary School Students' Inferential Reasoning About Scientific Concepts .*School Science and Mathematics,* 101(3), 133-142 .

Yuruk , N. & Geban , O .(2001). Conceptual Change Text : A Supplementary Material to Facilitate Conceptual Change in Electrochemical Cell Concepts .*A Paper Presented at Annual meeting of the National Association for Research in Science Teaching ,* St.Lois , MO.

APPENDIX A

INSTRUCTIONAL OBJECTIVES

1. To understand the atoms and molecules concepts

2. To define an atom and molecule.

3. To discriminate the element and compound .

4. To understand electrons ,protons and neutrons.

5. To define the atomic number and mass .

6. To discriminate size of atoms and molecules .

7. To undersand contribution of the nucleus to atomic mass.

8. To find electrons placement in an atom..

9. To know the factors that affect the speed of atoms and molecules .

10. To comprehend the effect of energy on atoms and molecules .

11. To comprehend the effect of temperature on atoms and molecules

12. To understand the structure of an atom.

13. To discriminate atoms and molecules .

14. To understand relationship proton ,neutron and electrons within an atom .

15. To discriminate size of atoms from the other objects .

16. To understand the phases of a substace at molecular level ..

APPENDIX B

ATOMS AND MOLECULES CONCEPTS TEST
(ATOM AND MOLEKÜL KAVRAM TESTİ)

This test was designed to measure and evaluate your learning of atoms and molecules in chemistry course. It consists of 24 multiple choice questions.

(Bu test kimyada atom ve moleküller konusundaki bilginizi ölçme ve değerlendirmek için hazırlanmıştır .)

1- Atomun görülebilirliği hakkında aşağıda verilen ifadelerden hangisi doğrudur?

a) Atomlar normal(optik) mikroskoplarla görülebilirler .

b) Atomlar çok özel teknolojik mikroskoplarla görülebilirler .

c) Bazı atomlar görülebilir bazıları ise görülemezler .

d) Atomlar hiçbir şekilde gerçek görüntüleri ile görülemezler .

e) Atomlar kimyasal reaksiyona girdikten sonra gerçek görüntüleri alınabilir.

2- Aşağıda elektronlarla ilgili verilen ifadelerden hangisi ya da hangileridoğrudur ?

I –Elektronlar atomda çekirdeğe eşit mesafededirler .

II- Elektronlar çekirdek etrafında eliptik bir yörüngede büyük bir hızla dönerler .

III- Elektronların tam olarak nerede olduğu söylenemez ama nerede oldukları tahmin edilebilir .

a) II b) I c) III d)I-II e) II-III

3- Aşağıda protonlarla ilgili ifadelerinden hangisi ya da hangileri doğrudur?

I- Proton sayısı atom numarasına eşittir ,

II-Protonlar atom çapını belirleyen ana etkendir ,

III- Protonlar atomun yapısı içinde önemli derecede hacim kaplarlar .

a) I b) II c) I-III d) II-III e) I-II-III

4- Atomların yapısı ile ilgili ;

I- Elektronlar atomik kütlenin önemli bir bölümünü oluşturur,

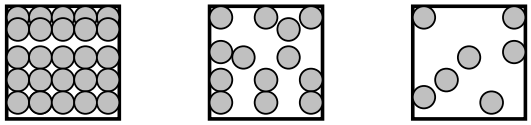
II- Atomların kütlelerinin büyük kısmı çekirdeğindedir ,

III- Tüm atomların kütleleri eşittir ,

ifadelerinden hangisi ya da hangileri yanlıştır?

a) I b) I-II c) III d) I-III e) I-II-III

5-



katı sıvı gaz

Aynı elementin katı –sıvı ve gaz durumlarındaki atomlar için verilenlerden hangisi doğrudur?

a) Elementin atomları her üç halde de katı durumdadır.
b) Element gaz durumundayken atomlar en hafif durumundadır .
c) Katı durumdayken atomlar hareketsiz durumdadırlar .
d) Katı haldeyken atomlarda az da olsa bir titreşim vardır .
e) Atomların hacimleri gaz durumunda en fazladır .

6- Atomun yapısı ile ilgili ;

I . Atomdaki nötron sayısı proton sayısına her zaman eşittir ,

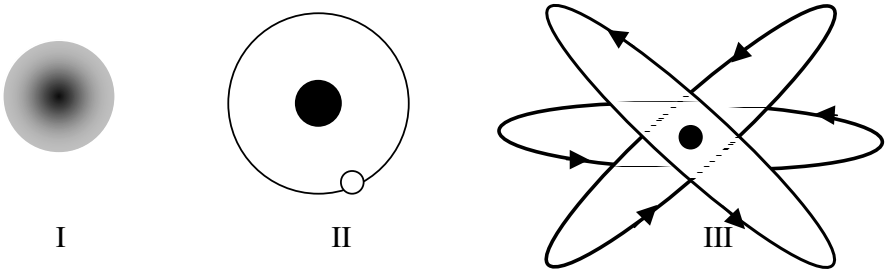
II . Atomik kütle proton ,nötron ve elektron sayısına eşittir ,

III . Atomların büyüklükleri her zaman eşittir ,

ifadelerinden hangisi ya da hangileri yanlıştır ?

a) I b) II c) III d)II- III e) I-II-III

7-



I II III

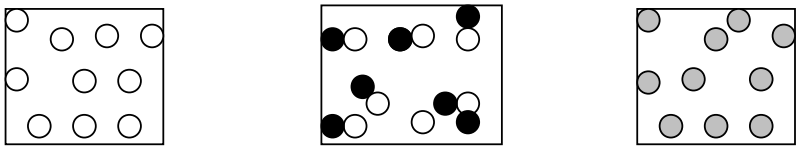
Hidrojen atomu için verilen yukarıdaki modellerin hangisi ya da hangileri modern atom teorisinin öngördüğü atom modeline en yakındır ?

a) I b)I- II c) II-III d) I-III e) I-II-III

8) $_{14}X$ elementinin elektron dizilişinde en dıştaki son orbitalin enerji seviyesi ile ,türü ve elektron sayısı hangisinde doğru olarak verilmiştir ?

	Enerji seviyesi	Türü	Elektron sayısı
a)	3	p	4
b)	3	s	2
c)	2	p	8
d)	2	p	2
e)	3	p	2

9)



I II III

I . I. ve II . Kap element , III . kap molekül içermektedir .

II . II ve III kap molekül , II .kap ise element içermektedir .

III . I ve III kap element , II .kap ise molekül içermektedir

IV . Her üç kaptaki atom ya da moleküllerin çok teknolojik aletlerle gerçek Görüntüleri elde edilebilir .

Yukarıda verilen ifadelerden hangisi ya da hangileri doğrudur ?

a) I b) I-II c)III d) III-IV e) IV

10) X^{+2} iyonu ve X atomu ile ilgili hangi yorum yanlıştır?

a) Atom kütleleri eşittir .

b) X^{+2} iyonu X atomunun iki elektron vermesiyle oluşmuştur.

c) X^{+2} iyonunun atom çapı X atomunun çapından büyüktür .

d) X atomunun atom çapı X^{+2} iyonununkinden büyüktür.

e) Proton sayıları eşit olduğundan atom çapları eşittir .

11-

I .Helium atomunun atom çapı H_2O (su) molekülünün atom çapından büyüktür.

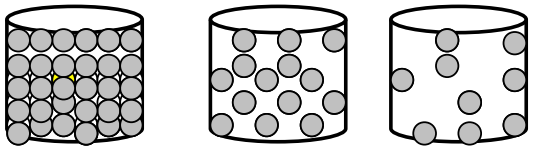
II . H_2O (su) molekülü gerçek görüntüsü görülebilecek kadar büyüktür.

III . Bir su molekülü (H_2O) üç atomdan oluşmuştur .

Yukarıda verilen ifadelerden hangisi ya da hangileri doğrudur?

a) I b) II c) III d) I-II e) I-II-III

12-



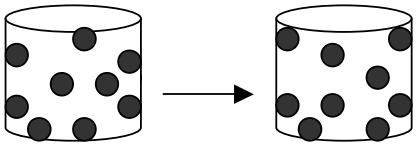
Buz su su buharı

I II III

Yukarıda aynı şartlar altında kaplar içinde suyun katı sıvı ve gaz durumlarındaki halleri verilmiştir . Buna göre bu kaplarda moleküllerin titreşim hızları ilgili aşağıdakilerden hangisi doğrudur ?

a) Üç durumda da titreşim hızları aynıdır.
b) I ve II . kapta eşit , III kapta en hızlıdır .
c) I .kapta titreşim yoktur.
d) III .kapta titreşim en hızlıdır .
e) II.kapta titreşim en hızlıdır .

13-



$10\ ^0C$ $90\ ^0C$

Yanda verilen kaptaki sıvı ısı verilerek sıcaklığı $90\ ^0C$ 'e artırılıyor .Buna göre verilenlerden hangisi ya da hangileri doğrudur?

I. Sıvıdaki moleküller genleşmiştir .

II. Sıvı genleşmiştir .

III. Sıvı moleküllerinin titreşimleri artmıştır.

a) I b) II c) I-II d) II-III e) I-II-III

14)

I – Katı durumdayken maddenin molekülleri en küçük hacimdedir .

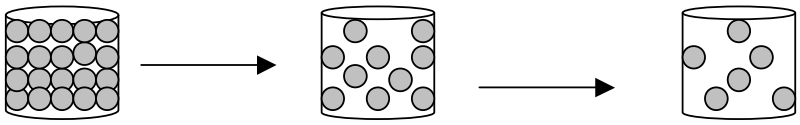
II- Gaz durumdayken maddenin molekülleri en büyük hacimdedir .

III-Aynı maddenin katı , sıvı ve gaz durumlarında molekül hacimleri değişmez.

Yargılarından hangisi ya da hangileri doğrudur ?

a) I b) II c) III d) I-II e) II-III

15)



I katı II sıvı III gaz

Yukarıda bir maddenin hal değişimi görülmektedir.Buna göre bu maddenin molekülleri ile ilgili yargılardan hangisi doğrudur?

a) I . durumda (katı halinde) maddenin molekülleri en ağır durumdadır .

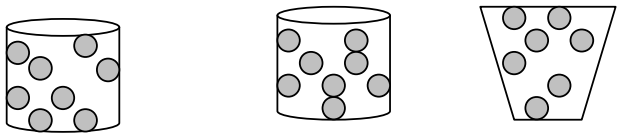
b) III.durumda (gaz halinde) maddenin molekülleri en hafif durumdadır.

c) II. Ve III. Durumlarda (sıvı ve gaz hallerinde) moleküllerin ağırlığı eşittir.

d) I . ve II .durumlarda (katı ve sıvı halinde) moleküllerin ağırlığı eşittir.

e) Üç durumda da maddenin moleküllerinin ağırlığı eşittir.

16)



I II III

10 ^{0}C 40 ^{0}C 10 ^{0}C

Yukarıda bir sıvının üç ayrı sıcaklık ve kaplarda durumu verilmiştir .Buna göre verilen ifadelerden hangisi doğrudur ?(verilen sıcaklıklar sıvının donma ve kaynama noktaları arasındadır.)

a) Kaplardaki sıvı maddenin moleküllerin şekilleri aynıdır.

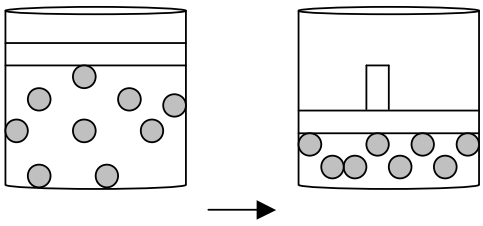
b)Sıcaklık farkından dolayı moleküllerin şekillerinde farklılıklar oluşmuş olabilir.

c)Kapların şekil farklılığından dolayı moleküllerin şekillerinde farklılıklar oluşmuş olabilir.

d)I ve III nolu kaplardaki sıvıların moleküllerinin şekilleri aynıdır.

e) I ve II nolu kaplardaki sıvıların moleküllerinin şekilleri aynıdır.

17)



I II

P 2P

2V V

T ^{0}C T ^{0}C

Yandaki sistemde I .durumda P basıncında 2V hacminde gaz molekülleri vardır.II.Durumda hareketli piston yardımıyla sıcaklık değiştirilmeden basınç 2P hacim de yarıya indirilmektedir. Buna göre gaz molekülleri için hangisi ya da hangileri doğrudur ?

I . II . durumda basınç 2P'ye arttığından olduğundan sistemdeki gaz moleküllerinin şekilleri değişir.

II. II.durumda gaz molekülleri sıkışmadan dolayı küçülmüş olabilir.

III. II . durumda gaz molekülleri sıkıştırılmıştır fakat şekillerinde bir değişme olmamıştır.

a) I b) II c) III d) I –III e) I-II-III

18) I . Küçük moleküller her zaman daha fazla titreşime sahiptirler.

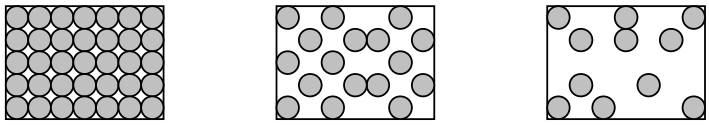
II. 20 ^{0}C de donmuş bir maddenin moleküllerinde titreşim yoktur .

III . Gaz moleküllerin ararsında daha fazla mesafe olduğundan daha hızlı hareket ederler.

İfadelerinden hangisi ya da hangileri yanlıştır ?

a) I b)II c) III d) I-III e) I-II-III

19)



-10 ^{0}C 15 ^{0}C 105 ^{0}C

I II III

Yanda üç ayrı sıcaklıkta suyun üç ayrı hali verilmiştir. Buna göre ifadelerinden hangisi ya da hangileri doğrudur ?

I. I . kaptaki su molekülleri katı durumdadır .

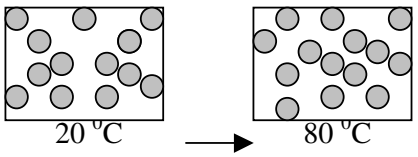
II. II .kaptaki su molekülleri sıvı durumdadır.

III. III .kaptaki su molekülleri gaz durumdadır.

IV. Üç ayrı kapta da su moleküllerinde enerji farkı vardır .

a) I b)I-II c) III d)IV e) I-II-III-IV

20)



20 ^{0}C 80 ^{0}C

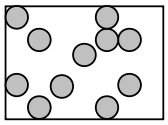
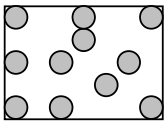
Yandaki kap içerisindeki sıvı ısıtılarak sıcaklığı80 ^{0}C ‘e çıkarılmıştır . Buna göre verilenlerden ifadelerinden hangisi ya da hangileri doğrudur?

I – Sıvı moleküllerin ortalama hızı artmıştır.

II- Sıvı molekülleri hacimsel olarak artmıştır .

III-Moleküllerin toplam enerjisi artmıştır.

a) I b) II c) I-II d) I- III e) I-II-III

21)  

I II

Yan şekilde I.kapta sıvı bir element , II . kapta ise moleküllerden oluşan bir sıvı bulunmaktadır. Buna göre verilen ifadelerinden hangisi ya da hangileri doğrudur ?

a) I. Kaptaki elementin atomları gerçek görüntüleri elde edilebilir .

b) II.Kaptaki sıvının moleküllerinin gerçek görüntüleri elde edilebilir .

c) II.kaptaki sıvı moleküllerinin gerçek görüntüleri elde edilebilir , fakat I .kaptaki element atomlarınınki elde edilemez .

d) Her iki kapta ısıtılıp buharlaşma sağlandıktan sonra her iki kaptaki atom ve moleküllerin gerçek görüntüleri elde edilebilir.

e) Her iki kapta da gerçek görüntüler elde edilemez.

22) Atomun çekirdeği ile ilgili aşağıda verilenlerden hangisi doğrudur?

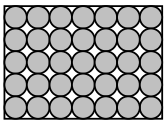
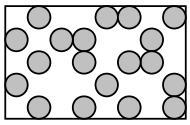
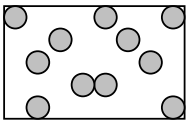
a) Atomun girdiği tüm kimyasal reaksiyonlar çekirdek tarafından yönetilir .

b) Atom ağırlığının büyük bir kısmı çekirdekte toplanmıştır .

c) Protonlar atomik çapı etkileyen baş etkendir

d) Atomun çapı çekirdeğin çapının birkaç katıdır.

e) Çekirdekteki nötronun protona oranı her zaman '' 1 '' dir .

23)   

$-20\ ^0C$ $30\ ^0C$ $100\ ^0C$

Yukarıda $-20\ ^0C$ ' de buz , $30\ ^0C$ 'de su ve $100\ ^0C$'de su buharı verilmiştir . V_b , buz moleküllerinin , V_s , su moleküllerinin ve V_g ise su buharının moleküllerinin ortalama hızlarını belirtmektedir . Buna göre aşağıda verilen karşılaştırmalardan hangisi doğrudur?

a) $V_b < V_s < V_g$ b) $V_b = V_s < V_g$ c) $V_b > V_s > V_g$

d) $V_b = V_s = V_g$ e) $V_b = 0$ $V_s < V_g$

24) Aşağıda elektronlarla ilgili verilen ifadelerden hangisi her zaman doğrudur?

I . Elektronlar atomun etrafında daire çizerler.

II . Elektronlar atomun etrafında bazen daire bazen de eliptik bir yörünge çizerler.

III . Elektronların bulunabildiği alanlar karmaşık şekillerdir .

a) I b) II c) III d) I-II e) I-II-III

25) Helyum atomu(He) ve CO_2 molekülü ve Sodyum (Na) atomunu büyüklük bakımından karşılaştırınız .

a) $He < Na = CO_2$ b) $He = Na < CO_2$ c) $He = Na = CO_2$

d) $He < Na < CO_2$ e) $He > Na > CO_2$

APPENDIX C

CONCEPTUAL CHANGE TEXT

Many people may have some difficulties to understand chemistry or other Science subjects because of having wrong or hazy ideas .During the learning naturally occurring phenomena in the scicence course , people may misinterpret the new knowledge . Atoms and molecules have vital role in understanding other chemistry courses and it possible to misinterpret concepts of an atom and a molecule for people.

Everything you can see all around the World are made up atoms .They are known as building blocks of matter .Comparison of atoms and molecules can be confusing concepts between people . Molecules have bigger size than atoms , because same or different atoms combine to for m molecules. Atoms and molecules are the small units of the matter. Atoms look like letters of an alphabet and molecules look like words which made up by letters of this alphabet (see Figure 1).Atoms and molecules are so small that we cannot see even if we use different magnifiying tools . For example ; a glass of water contains 20 000 000 000 000 000 000 000 atoms , or only a drop of water contains billions of water molecules .

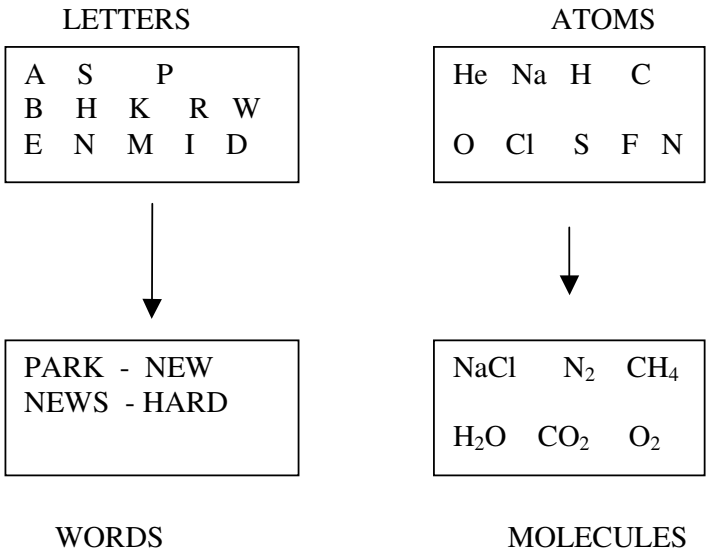


Figure C.1

However ,some people may think that one can see the real image of an atom .Indeed we sometimes see images of atoms depicted on text books like picture 1.

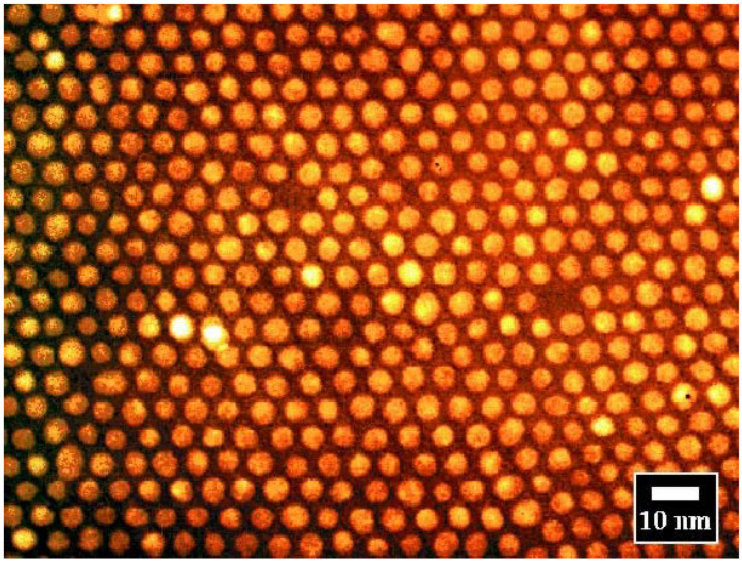


Figure.C.2. Atoms of gold (Au_clusters)

Do these images represent the reality? Or Do these imeges show the real image of atoms ? Of course answer is no! Because these images are depicted by using sophisticated magnifying tools (scanning tunelling electron microscopes) . These kinds of images depicted on textbooks don't actually exist or they don't show the reality and they are only reflection of electrical potential of electrons of the atoms created by a computer .

What is an element ?

It is known that everything in the nature are made of atoms . Have you ever heard the word ''Element'' ? If answer isYES ,What is the relationship between elements and Universe ? Atoms are building blocks of elements and they are the smallest unit of them. Elements are the pure substances that are comprised of the same type atoms having the same properties. Everything in the universe is made of combinations of approximately 100 (more than 100) elements. Different elements have varying properties bucause of their atomic structure. Examples of the element are Helium , Hydrogen , Oxygen , Iron , Carbon , Nitrogen, Sodium , etc...

Atom and its Structure :

As it was stated earlier , atoms are building blocks of elements they can't be spilt further . Another way to say , an atom cannot be broken into smaller units without changing its chemical properties. If you have 1 ton , 1 kg , 1 gram of Helium atoms (one of the elements) or , 1 Helium atom ; all of those amount of atoms have the same properties . If you break Helium atom into smaller pieces , the newly broken pieces will be lost the properties of Helium atom . The logic behind this phenomena is the same for a radio . For example ; if you have 100 radios , or 50 radios ,or one radio , it would not make any difference that they all behave like other radios and make us listen to beautiful songs ,news and other radio programs.If you brake a radio into smaller pieces ,you would obtain pieces whose

properties were different each other such as speakers , cables , batteries , electronic tools , etc ...

What does an atom look like ?

Some people may think that an atom resembles a solid sphere with components inside . But , this idea is misleading because one can conceive that atoms would exist only as solid form within the solid phase of the substance and atoms survive their solid states when the substance change its phase into liquis and gaseous phase. In order to understand what an atom looks like and to correct this misconception , it is essential to understand what is going on inside the atom **!** As I stated earlier ,if an atom is broken smaller units ,the new units don't indicate same properties. So, What does an atom consist of ? What do you think of componets inside the atom ? Some people may give an answer that it has two componets. One of which is nucleus consisting of protons and neutrons and the other components are electrons orbiting around the nucleus . But, this picture is also misleading .Here , the word ''orbiting'' leads to misinterpretation in a person's mind. Electrons' motions around the nucleus cannot be defined as orbiting . In other words conditions related to electrons inside the atom lead to this picture . In order to prevent this misleading picture ,it is better to look at modern quantum view.

According to the this point of view , an atom has two regions and one of which is nucleus consisting of protons and neutrons and other of which is electron cloud region which represents regions around the nucleus in which electons are most likely to be found .We cannot say exaclty where an electron of atom is and we can only guess which areas electrons may be located.Hence we cannot say an atom resembles a solid sphere .

You can the understand this electron related conditions by looking at Figure-2.

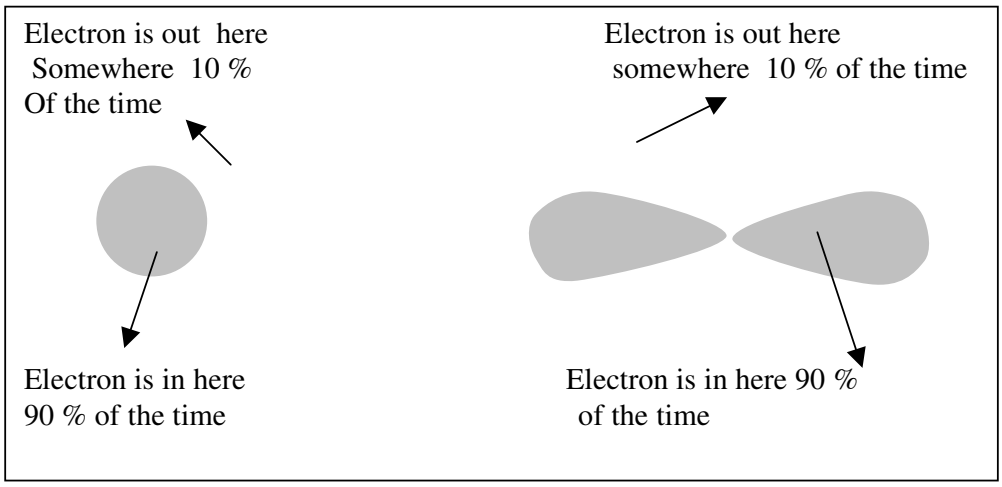


Figure. C.3 . Example of electrons' regions within an atom.

You can see two of the these high-probable electron regions whose shapes can be very complex . Misleading conceptions explain it as simple elliptical orbits . These general areas are called the shells which are also called energy levels . Energy levels or shells are labeled with capital letters such as first energy level (shell) is the K shell , the second shell is L , third one is M , etc... .Each shell have one or more than one subshells which are labeled as s , p , d , f . ''s '' subshell can hold up two electrons , ''p'' subshell can hold up six,''d' 'subshell can hold up ten and ''f '' subshell canhold up fourteen electrons. The sequence of addition electrons as the atomic number increases is given as follow :

1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s2 4d10 5p6 6s2 4f14 5d10 6p6 7s2 5f14 6d 10 7p6

According to this sequence , examples of electron configuration of some atoms :

Atomic number for a carbon atom :6 [C]: 1s2 2s2 2p2

Atomic number for a oxygen atom: 8 [O]: 1s2 2s2 2p4

Atomic number for an iron atom : 26 [Fe]: 1s2 2s2 2p6 3s2 3p6 4s2 3d6

As I said prevously , the other components of an atom is the nucleus which

consisting of protons and neutrons .The nucleus of the atom contains nearly all of the mass of the atom because , electrons are so much lighter than protons and neutrons . But , nucleus (therefore protons and neutrons) occupies only tiny fraction of volume of entire atom. Protons are positively charged and neutrons are uncharged , therefore whole the nucleus is positively charged . But , electrons carry negative charged . Number of protons in the nucleus is defined as atomic number .

Atomic number = Proton Number

Atoms of the same element have the same atomic number , but atoms of the different element will have different atomic numbers and therefore proton numbers. For a neutral atom ,number of protons and number of electrons are equal each other.

For an atom to be neutral ⟶ Number of electrons = Number of protons

Number of neutrons for the same element is not necessarily same for a certain element . In other words , an element's atoms may not have the same number of neutrons . Mass of an atom is defined as the sum of number of protons and number of neutrons . Some people may think that all the atoms have the same weight . But this is another misconception , because all kinds of atoms of elements have own specific mass . Atomic number (therefore proton number)has the same logic for genetic structure for people .Each person has own specific DNA in his/her genetic structure .Likewise , every atom of all kinds of elements have the specific atomic number (therefore proton number). This is the first reason of having different mass for atoms ,the second reason is that atoms of elements may have different neutrons numbers and some atoms have different neutron number even if

they belong to same elements .All these factors cause atoms of different elements to have different weights .

What about the atomic size ?  ?

Likewise, it can be said the same thing for it .It depends on atomic number and number of electrons inside the atom. Some people may have misconception that size of the atom is determined primarily by the protons' number . The nucleus (protons and neutrons) occupies tiny fraction of volume of entire volume of the atom .In order to conceive this tiny fraction of volume , let's assume that a proton was 1 cm in lenght so that electons would actually be approximately 0,5 km away from the nucleus . Protons have very small volume so that protons in the nucleus cannot primarily determine atomic size .

Molecules :

We have previously said that approximately 100(more than 100) elements are known in the universe . How do these elements form the million of substances we can see all around the world ? Answer is molecule and compound . Atoms combine to form molecules and compounds and as a result large amount of substances exist in the universe . A molecule is the smallest unit of a substance that shows all chemical properties of that substance .A molecule is a grup of same or different type of atoms that are bound tightly together by chemical bonds. If a molecule is broken up into its atoms or smaller groups of atoms , the new atom groups , or atoms won't behave like the original molecule. A compund is a substance made of molecules including two or more different chemical elements. Properties of a molecule are determined by atoms and how the atoms link each other within the molecule . Molecules in solid substances are close packed in a rigid form and their motion (vibtation) is very low . For liquids , molecules vibrate more fastly and freely than the molecules in solid-state and bump each other.For example ; water molecules move more freely and fastly than molecules in ice . But , sometimes

people may confuse observable properties of substances with properties of molecules comprising these substances .People may have tendency to describe molecules in terms of observable properties of state of matter. Hence , people can say molecules exoand ,melt ,evaporate ,condense ...Each individual molecule within a substance can't maintain the observable properties of substance . As a result we cannot say that molecules in ice is solid spherical form or molecules in water is liquid and wet .Because , macroscopic properties of solid state belong to ice(solid state) and they don't belong to individual molecules in ice (H_2O molecules in ice).Likewise , macroscopic properties of being at liquid state belong to water , but they don't belong to individual molecules in water (H_2O molecules in water) .

What about the molecular weight and size of molecules with respect to three states of matter ?

Other topic that can be confused by people is the size and the molecular weight of the molecules of the substances . People may think that size and weight of molecules of a ubstance may change when the substance changes its state. For example; People may think of molecules as if molecules in ice were heavier than the molecules in water and molecules in water vapor .Likewise ,it can look as if molecules in gaseous state of a certain substance were the ligthest for some people. But ,in fact, neither weight nor size of the molecules of a certain substance can change with respect to its state . For instance ; a water molecule has the same size and weight at solid state , liquid state and at gaseous state . Molecules have some energy and move with different speed due to having some certain energy. Molecules at gaseous state move faster than molecules at solid state and liquid state ,because they have more energy. Likewise , we can see same relation ship between liquid and solid state . Molecules of liquid state vibrate more rapidly and have some more energy than molecues at solid state ,but they can still vibrate even if they are at solid phase. As a result , molecules within all three phases (solid ,liquid and gaseous states) have different speed and energy . Here ,people may think that

molecules of a substance are the lightest state when the substance is at gaseous phase and molecules are in the heaviest form at solid phase. These misconceptions can come from misinterpretation of gaseous state and solid state . Because, density of substances at gaseous state decreases and so does their mass per unit volume . In addition to this , molecules of a gas move freely through the air and move in every possible way .All these cause people to conceive the gas molecules as the lightest state .A gas of a substance expands to fill the container in which it is placed . Free motions of gas molecules is due to having certain speed and energy.Substances at solid phase have higher density and vibrates slowly so that it may look as if molecules of a solid phase were the heaviest.All these two conditions may cause people to confuse the weight of molecules at three states .

What about the size and shape of molecules ?

Similar misconception can be observed for the size of molecules .People may think in way that molecules expand when their phase is changed from solid to liquid or from liquid to gas phase. This may misconception can come from the misinterpretation of expansion of entire body of matter . Most of the substances expand if heat is given .People misinterpret this phenomena as if expansion occurred within each individual molecule .Actually ,It occurs entire body of the substance because of taking energy and increasing speed of the molecules.

A molecule's size range from the tiny ,diatomic(too small to see)molecules to very large molecules with thousands of atoms such as plastics and DNA molecules . And every molecule has a certain shape and size.The difference for molecular speed , energy or state of the molecules cannot affect the shape of molecules .But some people may not think so. Because, a substance has different size and shape at three states .It can be looked as if change in size and shape of substances was due to change in size and shape at molecular level .In fact ,One molecule has the same shape and size within the three phases. Shape and size of a molecule can be changed in case of a chemical reaction but cannot be changed with heat , pressure and any

change in molecular speed .Molecular size and shape depends on type and number of atoms and how these atoms link each other and arrange within the molecule's structure .

APPENDIX D

BİLİMSEL İŞLEM BECERİ TESTİ

AÇIKLAMA: Bu test, özellikle Fen ve Matematik derslerinizde ve ilerde üniversite sınavlarında karşınıza çıkabilecek karmaşık gibi görünen problemleri analiz edebilme kabiliyetinizi ortaya çıkarabilmesi açısından çok faydalıdır. Bu test içinde, problemdeki değişkenleri tanımlayabilme, hipotez kurma ve tanımlama, işlemsel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanması, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. Her soruyu okuduktan sonra kendinizce uygun seçeneği yalnızca cevap kağıdına işaretleyiniz.

Bu testin orijinali James R. Okey, Kevin C. Wise ve Joseph C. Burns tarafından geliştirilmiştir. Türkçe'ye çevrisi ve uyarlaması ise Prof. Dr. İlker Özkan, Prof. Dr. Petek Aşkar ve Doç. Dr. Ömer Geban tarafından yapılmıştır.

1. Bir basketbol antrenörü, oyuncuların güçsüz olmasından dolayı maçları kaybettiklerini düşünmektedir. Güçlerini etkileyen faktörleri araştırmaya karar verir. Antrenör, oyuncuların gücünü etkileyip etkilemediğini ölçmek için aşağıdaki değişkenlerden hangisini incelemelidir?

a. Her oyuncunun almış olduğu günlük vitamin miktarını.

b. Günlük ağırlık kaldırma çalışmalarının miktarını.

c. Günlük antrenman süresini.

d. Yukarıdakilerin hepsini.

2. Arabaların verimliliğini inceleyen bir araştırma yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini artırdığı yolundadır.

Aynı tip beş arabaya aynı miktarda benzin fakat farklı miktarlarda katkı maddesi konur. Arabalar benzinleri bitinceye kadar aynı yol üzerinde giderler. Daha sonra her arabanın aldığı mesafe kaydedilir. Bu çalışmada arabaların verimliliği nasıl ölçülür?

a. Arabaların benzinleri bitinceye kadar geçen süre ile.

b. Her arabanın gittiği mesafe ile.

c. Kullanılan benzin miktarı ile.

d. Kullanılan katkı maddesinin miktarı ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Araştırmacılar arabanın litre başına alabileceği mesafeyi etkileyebilecek değişkenleri araştırmaktadırlar. Aşağıdaki değişkenlerden hangisi arabanın litre başına alabileceği mesafeyi etkileyebilir?

a. Arabanın ağırlığı.

b. Motorun hacmi.

c. Arabanın rengi

d. a ve b.

4. Ali Bey, evini ısıtmak için komşularından daha çok para ödenmesinin sebeplerini merak etmektedir. Isınma giderlerini etkileyen faktörleri araştırmak için bir hipotez kurar. Aşağıdakilerden hangisi bu araştırmada sınanmaya uygun bir hipotez değildir?

a. Evin çevresindeki ağaç sayısı ne kadar az ise ısınma gideri o kadar fazladır.

b. Evde ne kadar çok pencere ve kapı varsa, ısınma gideri de o kadar fazla olur.

c. Büyük evlerin ısınma giderleri fazladır.

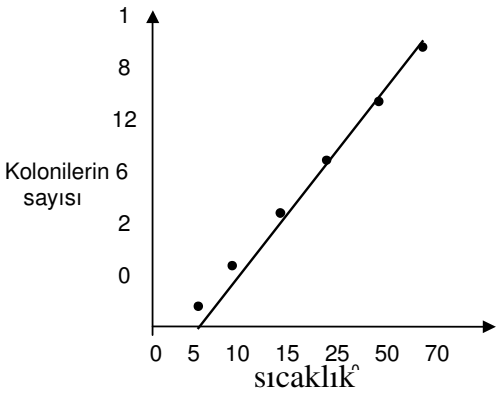
d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

5. Fen sınıfından bir öğrenci sıcaklığın bakterilerin gelişmesi üzerindeki etkilerini araştırmaktadır. Yaptığı deney sonucunda, öğrenci aşağıdaki verileri elde etmiştir:

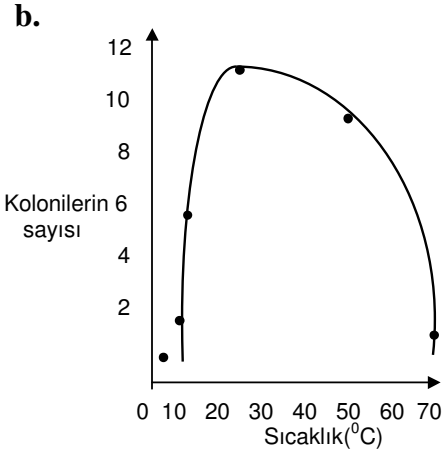
Deney odasının sıcaklığı (^{0}C)	Bakteri kolonilerinin sayısı
5	0
10	2
15	6
25	12
50	8
70	1

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?

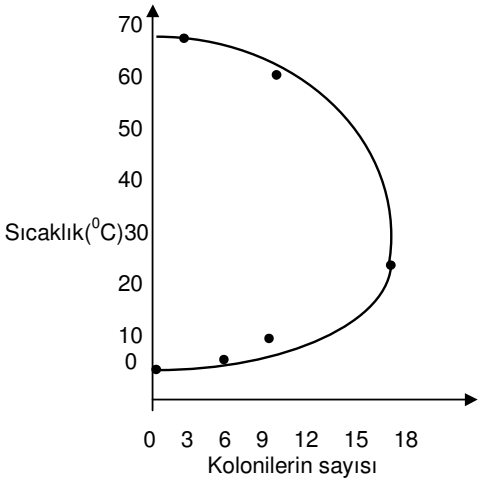
a.



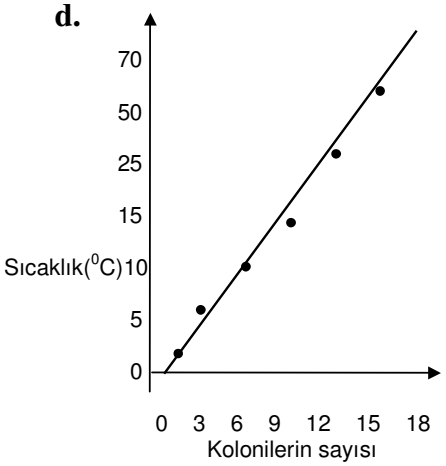
b.



c.



d.



6. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörler olduğunu düşünmektedir. Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?

a. Daha genç sürücülerin daha hızlı araba kullanma olasılığı yüksektir.

b. Kaza yapan arabalar ne kadar büyükse, içindeki insanların yaralanma olasılığı o kadar azdır.

c. Yollarda ne kadar çok polis ekibi olursa, kaza sayısı o kadar az olur.

d. Arabalar eskidikçe kaza yapma olasılıkları artar.

7. Bir fen sınıfında, tekerlek yüzeyi genişliğinin tekerleğin daha kolay yuvarlanması üzerine etkisi araştırılmaktadır. Bir oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğik düzlem) aşağı bırakılır ve daha sonra düz bir zemin üzerinde gitmesi sağlanır. Deney, aynı arabaya daha dar yüzeyli tekerlekler takılarak tekrarlanır. Hangi tip tekerleğin daha kolay yuvarlandığı nasıl ölçülür?

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.

b. Rampanın (eğik düzlem) eğim açısı ölçülür.

c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.

d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretebilmenin yollarını aramaktadır. Mısırların miktarını etkileyen faktörleri araştırmayı tasarlar. Bu amaçla aşağıdaki hipotezlerden hangisini sınayabilir?

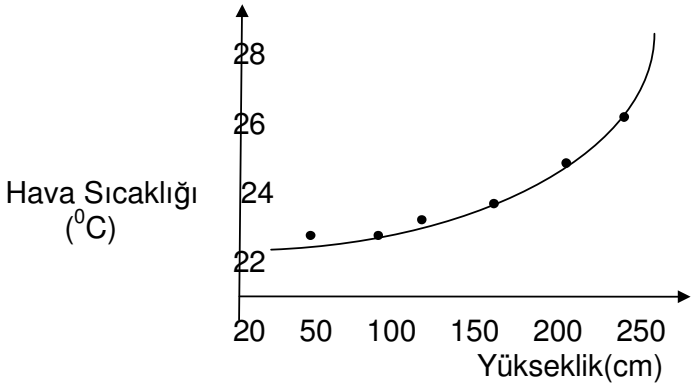
a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.

b. Ne kadar çok mısır elde edilirse, kar o kadar fazla olur.

c. Yağmur ne kadar çok yağarsa , gübrenin etkisi o kadar çok olur.

d. Mısır üretimi arttıkça, üretim maliyeti de artar.

9. Bir odanın tabandan itibaren değişik yüzeylerdeki sıcaklıklarla ilgli bir çalışma yapılmış ve elde edilen veriler aşağıdaki grafikte gösterilmiştir. Değişkenler arasındaki ilişki nedir?



a. Yükseklik arttıkça sıcaklık azalır.

b. Yükseklik arttıkça sıcaklık artar.

c. Sıcaklık arttıkça yükseklik azalır.

d. Yükseklik ile sıcaklık artışı arasında bir ilişki yoktur.

10. Ahmet, basketbol topunun içindeki hava arttıkça, topun daha yükseğe sıçrayacağını düşünmektedir. Bu hipotezi araştırmak için, birkaç basketbol topu alır ve içlerine farklı miktarda hava pompalar. Ahmet hipotezini nasıl sınamalıdır?

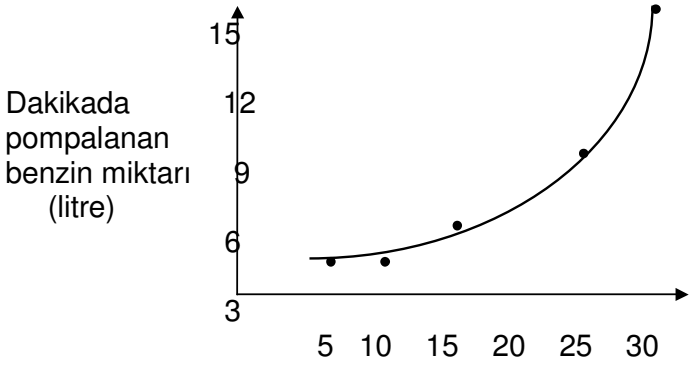
a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.

b. İçlerinde farlı miktarlarda hava olan topları, aynı yükseklikten yere bırakır.

c. İçlerinde aynı miktarlarda hava olan topları, zeminle farklı açılardan yere vurur.

d. İçlerinde aynı miktarlarda hava olan topları, farklı yüksekliklerden yere bırakır.

11. Bir tankerden benzin almak için farklı genişlikte 5 hortum kullanılmaktadır. Her hortum için aynı pompa kullanılır. Yapılan çalışma sonunda elde edilen bulgular aşağıdaki grafikte gösterilmiştir.



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi açıklamaktadır?

a. Hortumun çapı genişledikçe dakikada pompalanan benzin miktarı da artar.

b. Dakikada pompalanan benzin miktarı arttıkça, daha fazla zaman gerekir.

c. Hortumun çapı küçüldükçe dakikada pompalanan benzin miktarı da artar.

d. Pompalanan benzin miktarı azaldıkça, hortumun çapı genişler.

Önce aşağıdaki açıklamayı okuyunuz ve daha sonra 12, 13, 14 ve 15 inci soruları açıklama kısmından sonra verilen paragrafı okuyarak cevaplayınız.

Açıklama: Bir araştırmada, bağımlı değişken birtakım faktörlere bağımlı olarak gelişim gösteren değişkendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmanın amacına göre kimya başarısı bağımlı bir değişken olarak alınabilir ve ona etki edebilecek faktör veya faktörler de bağımsız değişkenler olurlar.

Ayşe, güneşin karaları ve denizleri aynı derecede ısıtıp ısıtmadığını merak etmektedir. Bir araştırma yapmaya karar verir ve aynı büyüklükte iki kova alır. Bunlardan birini toprakla, diğerini de su ile doldurur ve aynı miktarda güneş ısısı alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri

arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırmada aşağıdaki hipotezlerden hangisi sınanmıştır?

a. Toprak ve su ne kadar çok güneş ışığı alırlarsa, o kadar ısınırlar.

b. Toprak ve su güneş altında ne kadar fazla kalırlarsa, o kadar çok ısınırlar.

c. Güneş farklı maddeleri farklı derecelerde ısıtır.

d. Günün farklı saatlerinde güneşin ısısı da farklı olur.

13. Araştırmada aşağıdaki değişkenlerden hangisi kontrol edilmiştir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

14. Araştırmada bağımlı değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

15. Araştırmada bağımsız değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

16. Can, yedi ayrı bahçedeki çimenleri biçmektedir. Çim biçme makinesiyle her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı

olup bazılarında uzun bazılarında kısadır. Çimenlerin boyları ile ilgili hipotezler kurmaya başlar. Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?

a. Hava sıcakken çim biçmek zordur.

b. Bahçeye atılan gürenin miktarı önemlidir.

c. Daha çok sulanan bahçedeki çimenler daha uzun olur.

d. Bahçe ne kadar engebeliyse çimenleri kesmekte o kadar zor olur.

17, 18, 19 ve 20 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Murat, suyun sıcaklığının, su içinde çözünebilecek şeker miktarını etkileyip etkilemediğini araştırmak ister. Birbirinin aynı dört bardağın her birine 50 şer mililitre su koyar. Bardaklardan birisine 0 ^{0}C de, diğerine de sırayla 50 ^{0}C, 75 ^{0}C ve 95 ^{0}C sıcaklıkta su koyar. Daha sonra her bir bardağa çözünebileceği kadar şeker koyar ve karıştırır.

17. Bu araştırmada sınanan hipotez hangisidir?

a. Şeker ne kadar çok suda karıştırılırsa o kadar çok çözünür.

b. Ne kadar çok şeker çözünürse, su o kadar tatlı olur.

c. Sıcaklık ne kadar yüksek olursa, çözünen şekerin miktarı o kadar fazla olur.

d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

19. Araştırmanın bağımlı değişkeni hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

20. Araştırmadaki bağımsız değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

21. Bir bahçıvan domates üretimini artırmak istemektedir. Değişik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanırsa, o kadar çabuk filizleneceğidir. Bu hipotezi nasıl sınar?

a. Farklı miktarlarda sulanan tohumların kaç günde filizleneceğine bakar.

b. Her sulamadan bir gün sonra domates bitkisinin boyunu ölçer.

c. Farklı alanlardaki bitkilere verilen su miktarını ölçer.

d. Her alana ektiği tohum sayısına bakar.

22. Bir bahçıvan tarlasındaki kabaklarda yaprak bitleri görür. Bu bitleri yok etmek gereklidir. Kardeşi "Kling" adlı tozun en iyi böcek ilacı olduğunu söyler. Tarım uzmanları ise "Acar" adlı spreyin daha etkili olduğunu söylemektedir. Bahçıvan altı tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canlı bitleri sayar. Bu çalışmada böcek ilaçlarının etkinliği nasıl ölçülür?

a. Kullanılan toz yada spreyin miktarı ölçülür.

b. Toz yada spreyle ilaçlandıktan sonra bitkilerin durumları tespit edilir.

c. Her fidede oluşan kabağın ağırlığı ölçülür.

d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabın içine bir litre soğuk su koyar ve 10 dakika süreyle ısıtır. Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?

a. 10 dakika sonra suyun sıcaklığında meydana gelen değişmeyi kaydeder.

b. 10 dakika sonra suyun hacminde meydana gelen değişmeyi ölçer.

c. 10 dakika sonra alevin sıcaklığını ölçer.

d. Bir litre suyun kaynaması için geçen zamanı ölçer.

24. Ahmet, buz parçacıklarının erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarının büyüklüğü, odanın sıcaklığı ve buz parçalarının şekli gibi faktörlerin erime süresini etkileyebileceğini düşünür. Daha sonra şu hipotezi sınamaya karar verir: Buz parçalarının şekli erime süresini etkiler. Ahmet bu hipotezi sınamak için aşağıdaki deney tasarımlarının hangisini uygulamalıdır?

a. Her biri farklı şekil ve ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

b. Her biri aynı şekilde fakat farklı ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

c. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

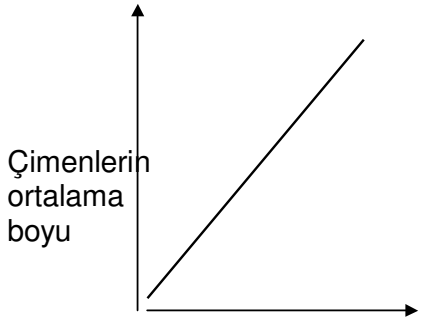
d. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar farklı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

25. Bir araştırmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlada yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır. Bir ay sonra, her tarlada yetişen çimenin ortalama boyunu ölçer. Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

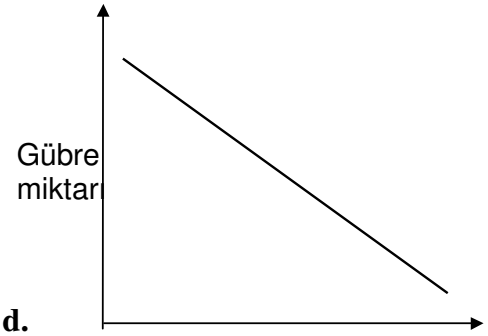
Gübre miktarı (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

Tablodaki verilerin grafiği aşağıdakilerden hangisidir?

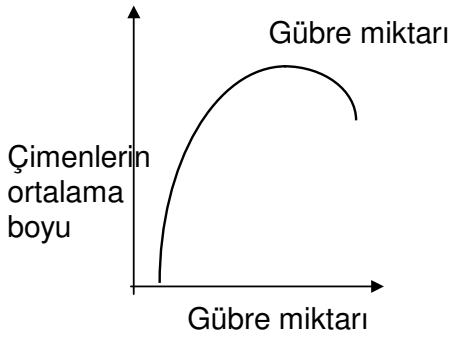
a.



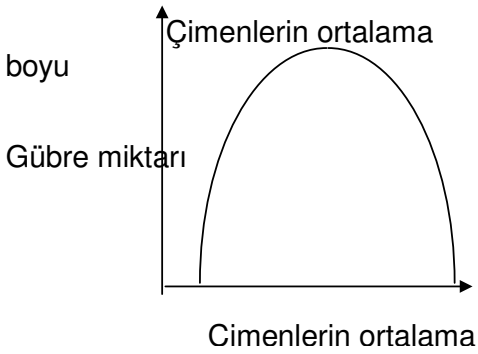
b.



c.



d.



26. Bir biyolog şu hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hızlı büyürler. Biyolog farelerin büyüme hızını nasıl ölçebilir?

a. Farelerin hızını ölçer.

b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.

c. Her gün fareleri tartar.

d. Her gün farelerin yiyeceği vitaminleri tartar.

27. Öğrenciler, şekerin suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekerin ve suyun miktarlarını değişken

olarak saptarlar. Öğrenciler, şekerin suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?

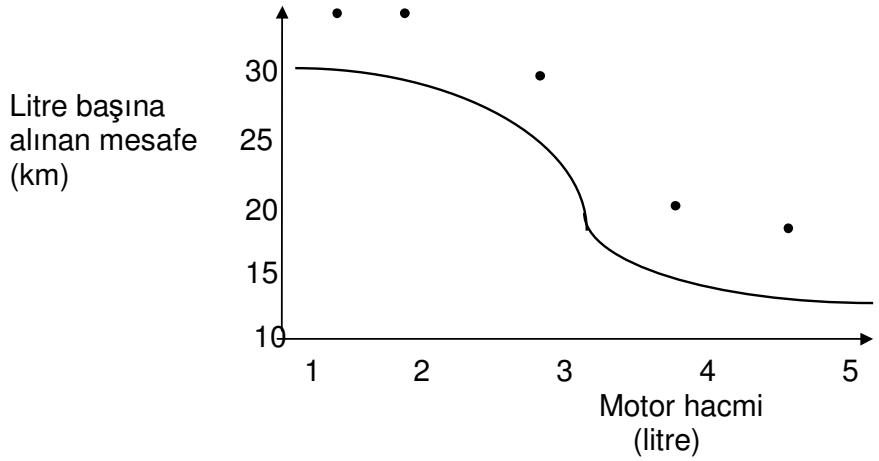
a. Daha fazla şekeri çözmek için daha fazla su gereklidir.

b. Su soğudukça, şekeri çözebilmek için daha fazla karıştırmak gerekir.

c. Su ne kadar sıcaksa, o kadar çok şeker çözünecektir.

d. Su ısındıkça şeker daha uzun sürede çözünür.

28. Bir araştırma grubu, değişik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların grafiği aşağıdaki gibidir:



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi gösterir?

a. Motor ne kadar büyükse, bir litre benzinle gidilen mesafe de o kadar uzun olur.

b. Bir litre benzinle gidilen mesafe ne kadar az olursa, arabanın motoru o kadar küçük demektir.

c. Motor küçüldükçe, arabanın bir litre benzinle gidilen mesafe artar.

d. Bir litre benzinle gidilen mesafe ne kadar uzun olursa, arabanın motoru o kadar büyük demektir.

29, 30, 31 ve 32 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Toprağa karıştırılan yaprakların domates üretimine etkisi araştırılmaktadır. Araştırmada dört büyük saksıya aynı miktarda ve tipte toprak konulmuştur. Fakat birinci saksıdaki torağa 15 kg., ikinciye 10 kg., üçüncüye ise 5 kg. çürümüş yaprak karıştırılmıştır. Dördüncü saksıdaki toprağa ise hiç çürümüş yaprak karıştırılmamıştır.Daha sonra bu saksılara domates ekilmiştir. Bütün saksılar güneşe konmuş ve aynı miktarda sulanmıştır. Her saksıdan elde edilen domates tartılmış ve kaydedilmiştir.

29. Bu araştırmada sınanan hipotez hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırlarsa, o kadar fazla domates verirler.

b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.

c. Saksılar ne kadar çok sulanırsa, içlerindeki yapraklar o kadar çabuk çürür.

d. Toprağa ne kadar çok çürük yaprak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada kontrol edilen değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki torak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

31. Araştırmadaki bağımlı değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki torak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

32. Araştırmadaki bağımsız değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki torak miktarı.

d. Çürümüş yapak karıştırılan saksı sayısı.

33. Bir öğrenci mıknatısların kaldırma yeteneklerini araştırmaktadır. Çeşitli boylarda ve şekillerde birkaç mıknatıs alır ve her mıknatısın çektiği demir tozlarını tartar. Bu çalışmada mıknatısın kaldırma yeteneği nasıl tanımlanır?

a. Kullanılan mıknatısın büyüklüğü ile.

b. Demir tozlarını çeken mıknatısın ağırlığı ile.

c. Kullanılan mıknatısın şekli ile.

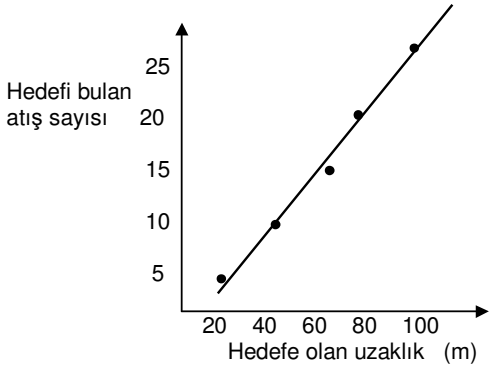
d. Çekilen demir tozlarının ağırlığı ile.

34. Bir hedefe çeşitli mesafelerden 25 er atış yapılır. Her mesafeden yapılan 25 atıştan hedefe isabet edenler aşağıdaki tabloda gösterilmiştir.

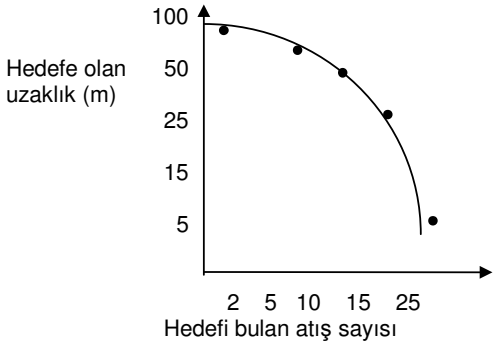
Mesafe(m)	Hedefe vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

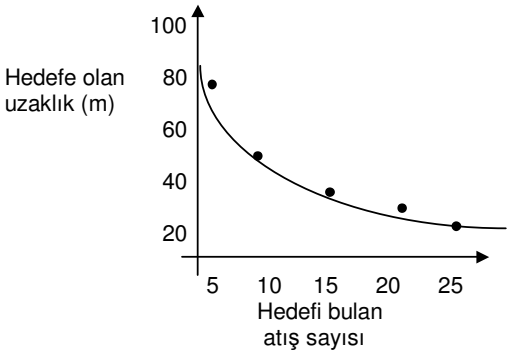
a.



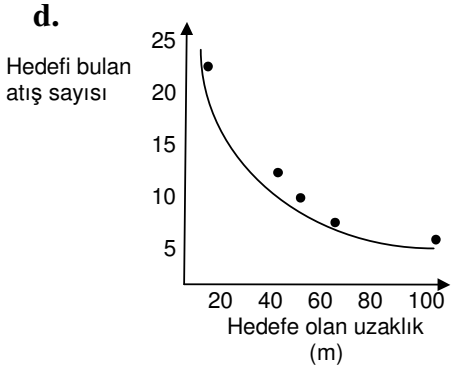
b.



c.



d.



35. Sibel, akvaryumdaki balıkların bazen çok hareketli bazen ise durgun olduklarını gözler. Balıkların hareketliliğini etkileyen faktörleri merak eder.Balıkların hareketliliğini etkileyen faktörleri hangi hipotezle sınayabilir?

a. Balıklara ne kadar çok yem verilirse, o kadar çok yeme ihtiyaçları vardır.

b. Balıklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçları vardır.

c. Su da ne kadar çok oksijen varsa, balıklar o kadar iri olur.

d. Akvaryum ne kadar çok ışık alırsa, balıklar o kadar hareketli olur.

36. Murat Bey'in evinde birçok elektrikli alet vardır. Fazla gelen elektrik faturaları dikkatini çeker. Kullanılan elektrik miktarını etkileyen faktörleri araştırmaya karar verir. Aşağıdaki değişkenlerden hangisi kullanılan elektrik enerjisi miktarını etkileyebilir?

a. TV nin açık kaldığı süre.

b. Elektrik sayacının yeri.

c. Çamaşır makinesinin kullanma sıklığı.

d. a ve c.

APPENDIX E

KİMYA DERSİ TUTUM ÖLÇEĞİ

Açıklama:Bu ölçek, Kimya dersine ilişkin cümleleri ile her cümlenin karşısında Tamamen Katılıyorum,Katılıyorum,Kararsızım,Katılmıyorum ve Hiç Katılmıyor-um olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatle okuduktan sonar kendinize uygun seçeneği işaretleyiniz.

	Tamamen Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1)Kimya çok sevdiğim bir alandır.					
2) Kimya ile ilgili kitapları okumaktan çok hoşlanırım.					
3) Kimyanın günlük yaşantıda çok önemli yeri yoktur.					
4)Kimya ile ilgili ders problemlerini çözmekten hoşlanırım.					
5)Kimya konularıyla ilgili daha çok şey öğrenmek isterim.					
6) Kimya dersine girerken büyük sıkıntı duyarım.					
7) Kimya derslerine zevkle girerim.					
8) Kimya dersine ayrılan ders saatinin daha fazla olmasını isterim.					
9) Kimya dersine çalışırken canım sıkılır.					
10)Kimya konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.					
11)Düşünce sisteminizi geliştirmede kimya öğrenimi önemlidir.					
12)Kimya çevremizdeki doğal olayların daha iyi anlaşılmasında yardımcı olur.					
13)Dersler içinde Kimya dersi bana sevimsiz gelir.					
14)Kimya konuları ile ilgili tartışmaya katılmak bana cazip gelmez.					
15)Çalışma zamanının önemli bir kısmını kimyaya ayırmak isterim.					